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REPORT OF THE PROCEEDINGS

OF THE

Thirtieth Annual Convention

OF THE

AMERICAN RAILWAY
MASTER MECHANICS' ASSOCIATION

(INCORPORATED)

HELD AT

OLD POINT COMFORT, VA.

June 15, 16 and 17, 1897.

CHICAGO:
THE HENRY O. SHEPARD COMPANY,
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AMERICAN RAILWAY MASTER MECHANICS' ASSOCIATION

(INCORPORATED).

OFFICERS FOR 1897-98:

PRESIDENT:

PULASKI LEEDS,
Louisville, Ky.

FIRST VICE-PRESIDENT:

ROBERT QUAYLE,
Chicago, Ill.

SECOND VICE-PRESIDENT:

J. H. McCONNELL,
Omaha, Neb.

THIRD VICE-PRESIDENT:

W. S. MORRIS,
Richmond, Va.

TREASURER:

J. N. BARR,
Milwaukee, Wis.

SECRETARY:

JOHN W. CLOUD,
Chicago, Ill.

COMMITTEES FOR CONDUCTING THE BUSINESS

FOR THE

YEARS 1897-98.

SUBJECTS FOR 1898 CONVENTION.

1.—Tonnage Rating for Locomotives.

G. R. HENDERSON,
F. HUFSMITH,
T. B. PURVES, JR.

2.—Advantage of Improved Tools for Railroad Shops.

T. W. GENTRY,
T. R. BROWNE,
JOHN PLAYER.

3.—Best Form of Fastening for Locomotive Cylinders.

J. E. SAGUE,
R. P. C. SANDERSON,
T. L. CHAPMAN.

4.—Best Method of Boiler and Cylinder Insulation.

J. H. MANNING,
J. F. DEEMS,
WM. McINTOSH.

5.—Efficiency of High Steam Pressure for Locomotives.

PROF. W. F. M. GOSS,
WM. FORSYTH,
TRACY LYON.

6.—Square Bolt Heads and Nuts; and Standards for Pipe Fittings (Joint with M. C. B. Association).

E. M. HERR,
C. H. QUEREAU,
W. H. MARSHALL.

7.—Air Brake and Signal Instructions (Joint with M. C. B. Association).

G. W. RHODES,
B. HASKELL,
A. W. BALL,
A. M. WAITT,
C. H. CORY.

8.—Standing Committee on Apprentice Boy.

W. F. BRADLEY,
W. H. HARRISON,
G. R. JOUGHINS,
A. E. MANCHESTER,
H. P. ROBINSON.

The discussion of the subject "Application of Electricity to Steam Railroads" was, by motion, made a part of the programme for 1898.

The following questions for discussion were not reached in 1897, and they were ordered to be carried over to 1898:

The Special Apprentice.

Is it possible to arrange Front Ends of Locomotives so they will clear themselves of cinders without throwing sparks?

The advisability of a systematic Course in Engineering in connection with Technical Schools.

The use of Steel in Locomotives.

CONSTITUTION AND BY-LAWS.

ARTICLE I.

NAME.

The name of this Association shall be the "American Railway Master Mechanics' Association.

ARTICLE II.

OBJECTS OF ASSOCIATION.

The objects of this Association shall be the advancement of knowledge concerning the principles, construction, repair and service of the rolling stock of railroads, by discussions in common, the exchange of information, and investigations and reports of the experience of its members; and to provide an organization through which the members may agree upon such joint action as may be required to give the greatest efficiency to the equipment of railroads which is intrusted to their care.

ARTICLE III.

MEMBERSHIP.

SECTION 1. The following persons may become active members of the Association, on being recommended by two members in good standing, signing an application for membership and agreement to conform to the requirements of the Constitution and By-Laws, or authorizing the Secretary to sign the Constitution for them:

(1) Those above the rank of general foreman, having charge of the design, construction or repair of railway rolling stock.

(2) General foremen, if their names are presented by their superior officers.

(3) Two representatives from each locomotive and car-building works.

SEC. 2. Civil and mechanical engineers, or other persons having such a knowledge of science or practical experience in matters pertaining to the construction of rolling stock as would be of special value to the Association or railroad companies, may become associate members on being recommended by three active members. The name of such candidate shall then be referred to a committee, to be appointed by the President, which shall investigate the fitness of the candidate and report to the Executive Committee of the Association at the next annual meeting. If the report be unanimous in favor of the candidate the name shall be submitted to ballot, and five dissenting votes shall reject. The number of associate members shall not exceed twenty, and they shall be entitled to all the privileges of active members, excepting that of voting.

SEC. 3. All members of the Association, excepting as hereafter provided, shall be subject to the payment of such annual dues as it may be necessary to assess for the purpose of defraying the expenses of the Association, provided that no assessment shall exceed $5 a year.

Such dues shall be payable when the amount thereof is announced by the President, at each annual meeting. Any member who shall be two years in arrears for annual dues, shall be notified of the fact, and if the arrears are not paid within three months after such notification, his name shall be taken from the roll and he be duly notified of the same by the Secretary.

SEC. 4. Any person who has been or may be duly qualified as a member of this Association will remain such until his resignation is voluntarily tendered, or he becomes disqualified by the terms of this Constitution. Members whose names have been dropped for non-payment of dues may be restored to membership by the unanimous consent of the Executive Committee on the payment of all back dues.

SEC. 5. Members of the Association who have been in good standing for not less than five years, and who through age or other cause cease to be actively engaged in the mechanical department of railway service, may, upon the unanimous vote of the members present at the annual meeting, be elected honorary members. The dues of the honorary members shall be remitted, and they shall have all the privileges of active members, exeept that of voting.

SEC. 6. Any member who, during the meetings of the Association, shall be guilty of dishonorable conduct which is disgraceful to a railroad officer and a member of the Association, or shall refuse to obey the Chairman when called to order, may be expelled by a two-thirds affirmative vote at any regular meeting of the Association held within one year from the date of the offense.

ARTICLE IV.

OFFICERS.

SECTION 1. The officers of the Association shall be a President, a First Vice-President, a Second Vice-President, a Third Vice-President, a Treasurer and a Secretary; and they, with the exception of the Secretary, shall constitute the Executive Committee of the Association.

ARTICLE V.

DUTIES OF OFFICERS.

SECTION 1. It shall be the duty of the President to preside at all the meetings of the Association, appoint all committees — designating the chairman — and approve all bills against the Association for payment by the Treasurer.

SEC. 2. It shall be the duty of the Vice-Presidents, according to rank, to perform the duties of the President in his absence from the meetings of the Association.

SEC. 3. In case of the absence of both President and Vice-Presidents, the members present shall elect a President *pro tempore*.

SEC. 4. It shall be the duty of the Secretary to keep a full and correct record of all transactions at the meetings of the Association; to keep a record of the names and places of residence of all members, and the name of the railway they each represent; to certify to the persons who are eligible as candidates for the Association's scholarships at the Stevens Institute of Technology; to receive and keep an account of all money paid to the Association and deliver the same to the Treasurer, taking his receipt for the amount; to receive from the Treasurer all paid bills, giving him a receipted statement of the same.

SEC. 5. It shall be the duty of the Treasurer to receive all money from the Secretary belonging to the Association; to receive all bills and pay the same, after having approval of the President; to deliver all bills paid to the Secretary at the close of each meeting, taking a receipted statement of the same, and to keep an accurate book account of all transactions pertaining to his office.

ARTICLE VI.

EXECUTIVE COMMITTEE.

SECTION 1. The Executive Committee shall exercise a general supervision over the interests and affairs of the Association, recommend the amount of the annual assessment, to call, to prepare for, and to conduct general conventions, and to make all necessary purchases, expenditures and contracts required to conduct the current business of the Association, but shall have no power to make the Association liable for any debt to an amount beyond that which at the time of contracting the same shall be in the Treasurer's hands in cash, but not subject to prior liabilities. All expenditures for special purposes shall only be made by appropriations acted upon by the Association at a regular meeting.

SEC. 2. The Executive Committee shall receive, examine and approve before public reading, all communications, papers and reports on all mechanical and scientific matters; they shall decide what portion of the reports, papers and drawings shall be submitted to each convention and what portion shall be printed in the annual report.

SEC. 3. Three members shall constitute a quorum for the transaction of business.

SEC. 4. The Executive Committee shall form with a committee of the Master Car Builders' Association a Joint Committee to decide on the place of meeting for the annual convention.

ARTICLE VII.

ASSOCIATION SCHOLARSHIPS.

It shall be the duty of the Secretary to issue a circular annually intimating the date and place when and where candidates may be examined for the scholarships of the Association in the Stevens Institute of Technology, Hoboken, New Jersey.

Acceptable candidates for the scholarship shall be, first, sons of members or of deceased members of the Association. If there is not a sufficient number of such applicants for the June examination, then applications will be received from other railroad employes or the sons of other railroad employes for the Fall examination. The Secretary shall issue a proper circular in this case as before. In extending the privilege outside of the families of members, preference shall be given to employes or the sons of employes, or the sons of deceased employes of the mechanical departments.

Candidates for these scholarships shall apply to the Secretary of this Association, and if found eligible shall be given a certificate to that effect for presentation to the school authorities. This will entitle the candidate to attend the preliminary examination. If more than one candidate passes the preliminary examination, the applicant passing the highest examination shall be entitled to the scholarship, the school authorities settling the question.

The successful candidate shall be required to take the course of mechanical engineering.

ARTICLE VIII.

ELECTION OF OFFICERS.

SECTION 1. The officers of the Association, except the Secretary as hereinafter provided, shall be elected by ballot separately without nomination at the regular meeting of the Association, held in June of each year. A majority of all votes cast shall be necessary to an election, and elections shall not be postponed.

SEC. 2. Two tellers shall be appointed by the President to conduct the election and report the result.

SEC. 3. A Secretary from among the members of the Association shall be appointed by a majority of the Executive Committee at its first meeting after the annual election, or as soon thereafter as the votes of a majority of the members of the Executive Committee can be secured for a candidate. The term of office of the Secretary thus appointed, unless terminated sooner, shall cease at the first meeting, after the next annual election succeeding his appointment, of the Executive Committee organized for the transaction of business. Two-thirds of the members of the Executive Committee shall have power to remove the Secretary at any time. His compensation, if any, shall be fixed for the time that he holds office by vote of the majority of the Executive Committee. He shall also act as Secretary of the Executive Committee.

ARTICLE IX.

AUDITING COMMITTEE.

SECTION 1. At the first session of the annual meeting an Auditing Committee, consisting of three members not officers of the Association, to be nominated by any member who does not hold office, shall be elected in the same way as officers are voted for. This Auditing Committee shall examine the accounts and vouchers of the Treasurer and certify whether they have been found correct or not. After the performance of this duty they shall be discharged by the acceptance of their report by the Association.

COMMITTEE ON SUBJECTS FOR INVESTIGATION AND DISCUSSION.

SEC. 2. At each annual meeting the President shall appoint a committee whose duty it shall be to report at the next annual meeting subjects for investigation and discussion, and if the subjects are approved by the Association the President, as hereinafter provided, shall appoint committees to report on them. It shall also be the duty of the committee to receive from members questions for discussion during the time set apart for that purpose. This committee shall determine whether such questions are suitable ones for discussion, and if so, they shall so report them to the Association.

COMMITTEES ON INVESTIGATION.

SEC. 3. When the Committee on Subjects has reported, and the Association approved of subjects for investigation, the President shall appoint special committees to investigate and report on them, and may authorize and appoint a *special* committee to investigate and report on any subject which a majority of the members present may approve.

ARTICLE X.

AMENDMENTS.

SECTION 1. This Constitution may be amended at any regular meeting by a two-thirds vote of the members present, provided that written notice of the proposed amendments has been given at a previous meeting at least six months before.

BY-LAWS.

TIME OF MEETING.

I. The regular meeting of the Association shall be held annually on the third Tuesday in June.

HOURS OF SESSION.

II. The regular hours of session shall be from 9 o'clock A.M. to 2 o'clock P.M.

PLACE OF MEETING.

III. Places for holding the Annual Convention shall be selected by a Joint Committee composed of the President, two Vice-Presidents, Secretary and Treasurer of this Association, and the President, three Vice-Presidents and Secretary of the Master Car Builders' Association. This Joint Committee shall meet within six months after the convention and decide upon a place of meeting, the place receiving the largest number of votes to be selected.

QUORUM.

IV. At any regular meeting of the Association, fifteen or more members entitled to vote shall constitute a quorum.

ORDER OF BUSINESS.

V. The business of the meetings of this Association shall, unless otherwise ordered by a vote, proceed in the following order :

1. Opening prayer.
2. Address by the President.
3. Acting on the minutes of the last meeting.
4. Reports of Secretary and Treasurer.
5. Assessment and announcement of annual dues.
6. Election of Auditing Committee.

7. Unfinished business.
8. New business.
9. Reports of committees.
10. Reading of papers and discussion of questions propounded by members.
11. Routine and miscellaneous business.
12. Election of officers.
13. Adjournment.

QUESTIONS FOR DISCUSSION, SPECIAL ORDER OF.

VI. Unless otherwise ordered, the discussion of questions proposed by members shall be the special order from 12 o'clock M. to 1 P.M. of each day of the annual meeting.

DECISIONS.

VII. The votes of a majority of the members shall be required to decide any question, motion or resolution which shall come before the Association, unless otherwise provided.

DISCUSSIONS.

VIII. No patentees or their agents shall be admitted in the meetings of the Association for the purpose of advocating the claims of any patent or patentee, unless by unanimous consent.

IX. No member shall speak more than twice in the discussion of any question until all the other members who want to speak, and have not been heard, have spoken.

NAMES AND ADDRESSES OF MEMBERS.

ACTIVE MEMBERS.

JOINED.	NAME.	ROAD.	ADDRESS.
1896	Adams, Abraham	Great Northern	Willmar, Minn.
1896	Adams, T. E.	Great Northern	Melrose, N. D.
1888	Addis, J. W.	Texas & Pacific	Marshall, Tex.
1895	Aiken, C. L.	Boston & Maine	Worcester, Mass.
1887	Aldcorn, Thos.		917 Havemeyer Bldg., New York City.
1892	Allen, G. S.	Ph. & Reading	Tamaqua, Pa.
1894	Allin, Richard	Arkansas Midland	Helena, Ark.
1895	Amann, W. E.		1536 St. Charles st., Alameda, Cal.
1886	Ames, L.		Jersey Shore, Pa.
1892	Antz, Oscar	L. S. & M. S.	Cleveland, Ohio.
1887	Arp, W. C.	T. H. & I.	Terre Haute, Ind.
1890	Atkinson, R.	Canadian Pacific	Montreal, Que.
1896	Atterbury, W. W.	Penn. R. R. Co.	Altoona, Pa.
1887	Augustus, W.	Keokuk & Western	Centerville, Iowa.
1886	Austin, W. L.		Baldwin Loco. Wks., Philadelphia, Pa.
1896	Babcock, C. M.		McDonogleville, La.
1894	Balkam, S. T.		Calle Teatro No. 17, Monterey, N. L., Mexico.
1889	Ball, A. W.	Erie	Galion, Ohio.
1896	Bancroft, P. T.	C. S. & H.	Columbus, Ohio.
1894	Barnes, Chas. H.	B. & A.	Boston, Mass.
1888	Barnes, J. B.	Wabash	Springfield, Ill.
1877	Barnett, J. Davis	Grand Trunk	Stratford, Ont.
1890	Barnum, M. K.	Union Pacific	Box 68, North Platte, Neb.
1890	Barr, J. N.	C. M. & St. P.	Milwaukee, Wis.
1896	Barrow, A. R.	Northwestern	Sukkur, Scind, India.
1895	Bartlett, Henry	B. & M.	Boston, Mass.
1889	Battye, John E.	N. & W.	Shenandoah, Va.
1895	Bay, J. P.		Laramie, Wyo.
1885	Bean, John	Clev. Canton & South'n,	Canton, Ohio.
1889	Bean, S. L.	Northern Pacific	Brainerd, Minn.
1892	Beattie, A. L.	New Zealand Govt.	Addington, N. Z.
1894	Beaumont, J. G.	Southern R'ys of Peru	Arequipa, Peru.
1892	Bechhold, H. G.		50 Portland st., Cleveland, Ohio.
1885	Beckert, Andrew	L. & Nashville	Decatur, Ala.

JOINED.	NAME.	ROAD.	ADDRESS.
1896	Belcher, A. W	Ulster & Delaware	Rondout, N. Y.
1892	Beltz, A. J	Del. Sus. & Schuylkill	Drifton, Pa.
1892	Benson, A. E	Ulster & Delaware	Rondout, N. Y.
1891	Berry, J. H	C. N. O. & T. P	Oakdale, Tenn.
1892	Billingham, Jos	Baltimore & Ohio	Garrett, Ind.
1879	Bisset, John	W. C. & A	Wilmington, N. C.
1872	Blackall, R. C	Delaware & Hudson	Albany, N. Y.
1883	Blackwell, Chas	Mount Lookout	Cincinnati, Ohio.
1887	Boatman, F. P	Omaha & St. Louis	Stanberry, Mo.
1869	Boon, J. M		47 Rutger street, Utica, N. Y.
1893	Bond, I	Erie	Susquehanna, Pa.
1896	Bouchard, E. J	Mo. Kan. & Texas	Parsons, Kan.
1897	Bowles, C. K	Farmville & Powhatan	Chester, Va.
1890	Boyle, Wilson L	N. Y. Sus. & Western	Jersey City, N. J.
1895	Bradeen, A. A	L. S. & M. S	Cleveland, Ohio.
1895	Bradeen, J. O	L. S. & M. S	Norwalk, Ohio.
1888	Bradley, W. F	Ann Arbor	Durand, Mich.
1894	Branch, Geo. E	Wil. Newberne & Nor.	Wilmington, N. C.
1896	Brangs, P. H	D. L. & W	Hoboken, N. J.
1893	Brantner, Z. T	Baltimore & Ohio	Brunswick, Md.
1892	Brehm, W. H	M. K. & Tex	Parsons, Kan.
1897	Briggs, D. D	L. & N	New Orleans, La.
1879	Briggs, R. H	K. C. M. & B	Memphis, Tenn.
1887	Brooke, Geo. D	St. Paul & Duluth	St. Paul, Minn.
1890	Brown, Angus	Northern Pacific	Livingston, Mont.
1892	Brown, David	D. L. & W	Scranton, Pa.
1887	Brown, F. R. F	Intercolonial	Moncton, N. B.
1891	Brown, J. L		Water Works, Allegheny, Pa.
1896	Brown, M. D	Mo. Kan. & Texas	New Franklin, Mo.
1891	Brown, W. A	Buffa. & Susque	Galeton, Pa.
1895	Browne, T. R	Penna	Altoona, Pa.
1882	Brownell, F. G		Muncie st., Muncie, Ind.
1891	Bruce, Frank	Montana Central	Great Falls, Mont.
1897	Bruce, Geo. A	Great Northern	Larimore, N. D.
1890	Bruck, Henry T	C. & Penn	Mt. Savage, Md.
1882	Bryan, H. S	D. & I. Range	Two Harbors, Minn.
1890	Bryant, J. T	R. F. & P	Richmond, Va.
1896	Buck, Geo. W	Great Northern	St. Paul, Minn.
1893	Buckalew, J. H	Mem. & Charleston	Memphis, Tenn.
1887	Buchanan, Wm	N. Y. C. & H. R	New York City.
1891	Burns, C. H	Hous. & Tex. Central	Houston, Tex.
1893	Bush, S. P	P. C. C. & St. L	Columbus, Ohio.
1870	Bushnell, R. W	B. C. R. & N	Cedar Rapids, Iowa.
1893	Butcher, Geo. W	San Antonio & A. Pass	San Antonio, Tex.
1861	Butler, L. M	N. Y. P. & B	Providence, R. I.
1890	Butterly, T. E	Wabash	Moberly, Mo.

JOINED.	NAME.	ROAD.	ADDRESS.
1896	Callender, R. J		Pernambuco, Brazil, S. A.
1883	Campbell, John	Lehigh Valley	Buffalo, N. Y.
1891	Campbell, John D	B. & Susquehanna	Galeton, Pa.
1896	Cannon, T. E	Great Northern	Barnesville, Minn.
1889	Carmody, T		Cleveland, Ohio.
1896	Carr, Jas	St. L. I. M. & S	Van Buren, Ark.
1885	Carson, M. T	Mobile & Ohio	Mobile, Ala.
1889	Casanave, F. D	Pennsylvania	Altoona, Pa.
1890	Casey, J. J	Haskell & Barker	Michigan City, Ind.
1892	Chamberlin, E		757 Prospect ave., Buffalo, N. Y.
1893	Chambers, Jno. S	Illinois Central	Clinton, Ill.
1878	Chapman, T. L		Orange Street, East Orange, N. J.
1897	Chase, F. A	Hannibal & St. Joseph	St. Joseph, Mo.
1893	Childs, H. A	Erie	Jersey City, N. J.
1895	Chipman, H. E	Oregon Pacific	Yaquina, Ore.
1896	Chubb, Thos. L	Buenos Ayres W	La Plata, Ar. Rep., S. A.
1894	Clark, Bernard	Erie	Susquehanna, Pa.
1870	Clark, David		Hazelton, Pa.
1886	Clark, Isaac W	C. F. & Y. V	Fayetteville, N. C.
1897	Clarke, Owen	Texas & Pacific	Marshall, Tex.
1803	Cleaver, F. C	L. E. & St. L. Con	Princeton, Ind.
1892	Clifford, C. J	C. L. S. & E	So. Chicago, Ill.
1887	Clifford, J. G		Tenth and Kentucky sts., Louisville, Ky.
1887	Cloud, John W		Rookery Bldg., Chicago, Ill.
1896	Coale, J. M	Northern Central	Baltimore, Md.
1895	Cockfield, Jos	C. & N.-W	Clinton, Iowa.
1891	Cockfield, Wm	Mexican Central	Chihuahua, Mex.
1896	Cole, F. J		Rogers Loco. Wks., Paterson, N. J.
1891	Collinson, Jas	G. C. & S. F	Galveston, Tex.
1890	Conolly, J. J	D. S. S. & A	Marquette, Mich.
1892	Conroe, I	A. T. & S. F	La Junta, Colo.
1892	Cooley, M. W	Southern Pacific	Fresno, Cal.
1879	Cook, John S	Georgia	Augusta, Ga.
1879	Cooke, Allen		Danville, Ill.
1891	Cooke, W. I	Chicago & Eastern Ill.	Momence, Ill.
1876	Cory, C. H	C. H. & D	Lima, Ohio.
1894	Cory, J. L	D. & H. C	Green Island, N. Y.
1892	Crawford, S. B	B. & O. R. R	Parkersburg, W. Va.
1885	Cromwell, A. J		1411 Hollins st., Baltimore, Md.
1893	Cross, W	Canadian Pacific	Winnipeg, Man.
1883	Cullen, Jas	N. C. & St. L	Nashville, Tenn.
1896	Cullinan, J	Norfolk & Western	Portsmouth, Ohio.
1872	Cushing, G. W		Evanston, Ill.
1888	Dallas, Wilber C		920 Forrest st., St. Paul, Minn.
1894	Daniels, A. A	C. O. & S.-W	Paducah, Ky.

JOINED.	NAME.	ROAD.	ADDRESS.
1890	Davies, J. M	Chateaugay	Lyon Mt., N. Y.
1892	Davis, Ed E	Phila. & Reading	Reading, Pa.
1893	Davis, Wm. John	Pitts. & Western	Foxbury, Pa.
1897	Dawson, E	K. C. P. & G	Pittsburg, Kan.
1894	Deeble, Wm. R	Tasmania Govt	Hobart, Tasmania.
1891	Deems, J. F	C. B. & Q	West Burlington, Iowa.
1896	De Gress, C	Mex. Nat. Construc. Co.,	Colima, Mex.
1892	Dehn, F. H	Texas Central	Walnut Springs, Tex.
1897	Delaney, C. A	Supt. Richmond Loco. Wks.,	Richmond, Va.
1895	Delaney, H		New Albany, Ind.
1893	Derby, Abram		Warren, Ohio.
1894	De Witt, Chas. H	Lehigh Valley	Delano, Pa.
1896	Dickerson, S. K	Norfolk & Western	East Radford, Va.
1887	Dickson, G. L	Dickson Loco. Works,	Scranton, Pa.
1894	Dixon, W. F	Sormovo Co.,	Philadelphia, Pa.
1897	Doebler, C. H	Wabash	Ft. Wayne, Ind.
1890	Dolbeer, Alonza		99 Lexington ave., Rochester, N. Y.
1896	Donahue, Geo	Erie	Meadville, Pa.
1892	Dorsey, J. B		Parkersburg, W. Va.
1880	Dotterer, D. H		45 Wellington ave., Rochester, N. Y.
1893	Dow, Jas. M	Tol. & Ohio Central	Kenton, Ohio.
1890	Downing, T		Station E, Minneapolis, Minn.
1896	Driscoll, J. L	Catskill Mountain	Catskill, N. Y.
1893	Drury, Michael J	A. T. & S. F	Arkansas City, Kan.
1894	Duncan, T. G		Chillicothe, Ohio.
1896	Dunn, J. F	Oregon Short Line	Salt Lake City, Utah.
1869	Elliott, Henry		East St. Louis, Ill.
1895	Ellis, John	Maine Central	Waterville, Me.
1893	Ellis, John J	C. St. P. M. & O	St. Paul, Minn.
1897	Elvin, A. G	Ches. & Ohio	Huntington, W. Va.
1893	English, H. W	Birmingham R'y & Elec. Co.,	Birmingham, Ala.
1893	English, Richard	Santa Fe Pacific	Albuquerque, N. M.
1881	Ennis, W. C	N. Y. S. & W	North Paterson, N. J.
1892	Esson, R. C	Southern Pacific	Newark, Cal.
1885	Fenwick, A	G. B. W. & St. P	Fort Howard, Wis.
1885	Ferguson, G. A		48 Staniford st., Boston, Mass.
1889	Ferry, F. J	L. H. & St. L	Cloverport, Ky.
1896	Fisher, G. P	Mo. Kan. & Texas	Terrell, Tex.
1892	Fitzmorris, Jas	Chic. Union Stock Yds.,	Chicago, Ill.
1895	Foller, P. P	W. N. Y. & Pa	Oil City, Pa.
1896	Foque, T. A	M. St. P. & S. Ste. M.	Minneapolis, Minn.
1888	Forsyth, Wm	C. B. & Q	Aurora, Ill.
1875	Foster, W. A	Fall Brook R'y Co	Corning, N. Y.
1890	Foulk, John	Jacksonville & St. Louis	Jacksonville, Ill.

JOINED.	NAME.	ROAD.	ADDRESS.
1877	Fowle, I. W	C. N. O. & Tex. Pac.	Somerset, Ky.
1887	Fraser, T. A		Wells & French Car Works, Chicago, Ill.
1891	French, R. E	Southern Pacific	Kern, Cal.
1890	Fuller, C E	Central Vermont	St. Albans, Vt.
1872	Fuller, Wm		213 Kennard st., Cleveland, Ohio.
1893	Gage, George W	St. L. S.-W	Pine Bluff, Ark.
1897	Gaines, F. F	Lehigh Valley	South Easton, Pa.
1891	Galbraith, R. M	St. L. S.-W	Pine Bluff, Ark.
1897	Gardner, A	C. & C. V	Cooperstown, N. Y.
1893	Garrick, J. R	Tex. & New Orleans	Beaumont, Tex.
1892	Garrison, P. E	West Shore	East Buffalo, N. Y.
1887	Garstang, Wm	C. C. C. & St. L	Indianapolis, Ind.
1886	Gentry, T. W	Richmond Loco. Wks	Richmond, Va.
1888	Gibbs, A. W	Pennsylvania	Altoona, Pa.
1890	Gibbs, George	C. M. & St. P	Milwaukee, Wis.
1896	Gill, Jno	C. R. I. & P	Horton, Kan.
1891	Gillis, H. A	Nor. & Western	Roanoke, Va.
1893	Gilmore, George	Jamaica	Kingston, Jamaica.
1883	Gilmore, W. L	L. S. & M. S	Elkhart, Ind.
1890	Givan, F. A	B. St. M. & S.-W	St. Mary's, Pa.
1897	Glaser, J	Cleveland & Marietta	Cambridge, Ohio.
1891	Glass, John C	Allegheny Valley	Verona, Pa.
1891	Gleasier, T. W	Mexican Central	Silao, Mex.
1891	Glover, J. B	Mar. & N. Georgia	Marietta, Ga.
1880	Gordon, H. D		71 John st., New York.
1879	Gordon, James T	Concord	Concord, N. H.
1891	Gould, Amos	N. Y. C. & H. R	East Buffalo, N. Y.
1892	Graham, Charles, Jr	D. L. & W	Kingston, Pa.
1894	Graham, J. A	Clev. Lorain & W	Lorain, Ohio.
1894	Grant, A. S	H. E. & W. T.	Houston, Tex.
1892	Gray, Robert	Southern Pacific	Tucson, Ariz.
1889	Greatsinger, G. L	D. & I. Range	Duluth, Minn.
1897	Greaven, Luis	Western R'y of B. A.	Caballito, Buenos Ayres, Arg. Rep., S. A.
1895	Green, Wilbur	S. A. & A. P	Yoakum, Tex.
1896	Greenwood, Alfred W.	East Broad Top	Rockhill Furnace, Pa.
1895	Gregory, Geo	Chicago Great Western	Oelwein, Iowa.
1891	Griffin, B. F	D. & I. Range	Two Harbors, Minn.
1885	Griffith, Fred B	D. L. & W	Buffalo, N. Y.
1872	Griggs, Albert	C. & E. Ill.	Danville, Ill.
1893	Gross, R. J		Brooks Loco. Wks., Dunkirk, N. Y.
1896	Groves, J. R	St. L. & S. F	Springfield, Mo.
1880	Hackney, Clem		Fox Solid Pressed Steel Co., Joliet, Ill.
1875	Haggett, J. C		Dunkirk, N. Y.

JOINED.	NAME.	ROAD.	ADDRESS.
1886	Haggerty, G. A.		Southbridge, Mass.
1893	Hainen, J.	Erie	Port Jervis, N. Y.
1896	Hall, J. W.	St. L. S.-W.	Commerce, Tex.
1891	Hancock, Geo. A.	A. T. & S. F.	Topeka, Kan.
1893	Hancock, Wm. S.	A. & Pacific	Needles, Cal.
1896	Hauglin, J. A.	Hot Springs	Malvern, Ark.
1893	Hardie, Jas.		Hardie & Co., Valparaiso, Chili.
1896	Harris, E. W.	Eureka & Palisade	Palisade, Nevada.
1888	Harris, Geo. D	Georgia Southern	Macon, Ga.
1896	Harrison, Jno.	San Paulo	San Paulo, Brazil, S. A.
1885	Harrison, W. H.	B. & O	Newark, Ohio.
1889	Haskell, B	Chic. & W. Mich.	Grand Rapids, Mich.
1888	Hassman, Wm.	Ill. Cent	Water Valley, Miss.
1875	Hatswell, T. J	F. & P. M.	Saginaw, E. S., Mich.
1897	Hatswell, T. J., Jr	F. & P. M.	Saginaw, E. S., Mich.
1895	Hawksworth, D	B. & M. River	Plattsmouth, Neb.
1896	Hayward, H. S	Penna	Jersey City, N. J.
1891	Hedley, E. M.	C. R. of N. J	Elizabethport, N. J.
1891	Hedley, F.	Lake Street Elevated	Chicago, Ill.
1896	Heers, L. B	C. N. Y. & W. R. R.	Angelica, N. Y.
1887	Heintzleman, T. W	Southern Pacific	Sacramento, Cal.
1888	Hemphill, W. J	Ch. Peoria & St. Louis.	Jacksonville, Ill.
1886	Hendee, A		1059 Oak st., Columbus, Ohio.
1892	Henderson, G. R.	Norfolk & Western	Roanoke, Va.
1897	Hennessey, T. J.	Michigan Central	Jackson, Mich.
1897	Hepburn, G. W	Ches. & Ohio	Hinton, W. Va.
1892	Herr, Edwin M	Northern Pacific	St. Paul, Minn.
1871	Hewitt, John		1323 So. Jefferson st., St. Louis, Mo.
1895	Hibbard, H. Wade	University of Minnesota.	Minneapolis, Minn.
1883	Hickey, John	Rio Grande Western	Salt Lake City, Utah.
1890	Higgins, S.	Lehigh Valley	S. Bethlehem, Pa.
1887	Hill, Jas. W	P. & Pekin Union	Peoria, Ill.
1892	Hill, Rufus	Pennsylvania	Pavonia, N. J.
1897	Hinchey, Jas.	Cent. Vermont	New London, Conn.
1892	Hinckley, A. C	St. Jo. & Gr. Island	St. Joseph, Mo.
1885	Hinman, M. L.		Brooks Loco. Wks., Dunkirk, N. Y.
1894	Hiser, Edwin C	Adirondack & St. L.	Utica, N. Y.
1883	Hoffecker, W. L	Central of N. J.	Elizabethport, N. J.
1896	Hogsett, C. E.	Arizona & New Mexico.	Clifton, Arizona.
1896	Holland, I. J	Guatemala Northern	Gualon, Guat., C. A.
1892	Holland, W. D		Caracas, Venezuela, S. A.
1885	Holman, W. L.	Pennsylvania	Renovo, Pa.
1890	Homer, John C	Cin. P. & Virginia	Portsmouth, Ohio.
1896	Hopwood, Jno	Argentine Gt. West.	Mendoza, Argentine, Rep., S. A.
1896	Horrigan, Jno.	E. J. & E. R. R.	Joliet, Ill.
1892	Howard, C. H.		Union Trust Bldg., St. Louis, Mo.

JOINED.	NAME.	ROAD.	ADDRESS.
1896	Howard, Jno	West Shore	New Durham, N. J.
1890	Hudson, E. E	C. C. C. & St. L	Bellefontaine, Ohio.
1892	Hudson, W. H	Southern	Atlanta, Ga.
1890	Hufsmith, F	I. & G. N	Palestine, Tex.
1896	Hughes, W. S	New England	Providence, R. I.
1890	Humphrey, A. L	Colorado Mid	Colorado City, Colo.
1896	Hurst, J. M	Gt. S. L. & Hot Spgs	Salt Lake City, Utah.
1895	Hutchinson, Wm	C. & North-Western	Eagle Grove, Iowa.
1896	Hyndman, F. T	Pitts. & Western R'y	Allegheny, Pa.
1896	Inge, T. S		Columbia, S. C.
1888	Jackson, O. H	S. F. P. & P	Prescott, Ariz.
1896	James, Geo	N. Y. C. & St. L	Stony Island, Ill.
1890	Jennings, Wm	Mexican Inter	Ciudad Porfirio, Diaz, Mex.
1893	Jerome, E. W		557 Second st., Albany, N. Y.
1896	Johnson, A. B		Baldwin Loco. Wks., Philadelphia, Pa.
1878	Johnson, J. B	A. Midland	Helena, Ark.
1887	Johnson, L. R	Canadian Pacific	Vancouver, B. C.
1887	Johnstone, F. W	Mexican Central	City of Mexico, Mex.
1888	Joughins, G. R	Norfolk So	Berkley, Va.
1896	Justice, D. J	Atlantic Coast Line	Florence, S. C.
1890	Kalbaugh, I. N	B. & O	Baltimore, Md.
1896	Keegan, Jas. A	C. C. C. & St. L	Delaware, Ohio.
1892	Keegan, Jas. E	G. R. & Ind	Grand Rapids, Mich.
1890	Keith, J. M	W. R'y of Guatemala	San Filipe, Guatemala, C. A.
1896	Kells, Willard	Erie	Cleveland, Ohio.
1896	Kelly, Wm	Great Northern	Spokane, Wash.
1894	Kennedy, Jas	Jamaica	Kingston, Jamaica.
1893	Kenney, George W	Central Vermont	Rutland, Vt.
1890	Killen, W. E	Nev. Central	Battle Mt., Nev.
1868	Kinsey, J. I	Lehigh Valley	Easton, Pa.
1892	Kirk, John	A. T. & S. F	Arkansas City, Kan.
1892	Kissler, Lewis	D. L. & W.	Syracuse, N. Y.
1896	Knapp, E. W	Mex. National	Acambaro, Mex.
1890	Knapp, G	H. & Shen	Shenandoah, Iowa.
1894	Lang, V. B	Southern R'y	Louisville, Ky.
1895	La Lime, E	Northern Adirondack	Santa Clara, N. Y.
1896	Lamplugh, Q	Rio Grande Western	Salt Lake City, Utah.
1888	Lape, C. F	So. Cal	San Bernardino, Cal.
1895	Lauer, F. G	B. R. & Pittsburgh	Rochester, N. Y.
1889	Lavery, W	Erie	Cleveland, Ohio.
1891	Lawler, F. M	C. C. C. & St. L	Brightwood, Ind.
1891	Lawes, T. A	C. & E. I	Danville, Ill.
9681	Lawrence, J. L	Cumb. Valley	Chambersburg, Pa.

JOINED.	NAME.	ROAD.	ADDRESS.
1890	Leach, H. L.		Room 45, Mason Bldg., Boston, Mass.
1892	Lee, C. W.	Southern	Salisbury, N. C.
1896	Leech, C. C.		88½ Putnam st., Buffalo, N. Y.
1883	Leeds, Pulaski	L. & Nashville	Louisville, Ky.
1888	Leigh, F. J		Can. Loco. Wks., Kingston, Ont.
1895	Leite, Constantino d'Aquiens	Prolingamente de E. F. B. & S. Francisco.	Aramary, Bahia, Brazil.
1890	Leonard, A. G.	N. Y. Central	New York City.
1873	Lewis, W. H	D. L. & W.	Kingsland, N. J.
1876	Lewis, W. H	Norfolk & Western	Roanoke, Va.
1896	Lindoff, Geo.	Montana Union	Anaconda, Mont.
1896	Linstrom, Chas.	Yazoo & Miss. Valley	Vicksburg, Miss.
1890	Lloyd, T. S.	Ches. & Ohio	Richmond, Va.
1890	Logan, P. A	Can. Eastern	Gibson, N. B.
1895	Lonergan, P. T.	R. W. & O.	Oswego, N. Y.
1868	Losey, Jacob		Louisville Steam Forge Co., Louisville, Ky.
1890	Luttgens, H. A.		L. B. 639, Paterson, N. J.
1890	Luttrell, J. W.	Illinois Central	Chicago, Ill.
1894	Lyon, Tracy	Chic. Gr. Western	St. Paul, Minn.
1885	Lythgoe, Joseph		R. I. Loco. Wks., Providence, R. I.
1897	Lucas, W. O.	Central Argentine	Rosario, Arg. Rep., S. A.
1887	Macbeth, Jas.	N. Y. Central	Buffalo, N. Y.
1892	Macdonald, Aug. V.	New Zealand R'ys.	Newmarket, Auckland, N. Z.
1890	Macfarlane, T. W		Assumption, Ill.
1876	Mackenzie, John	N. Y. C. & St. L.	Cleveland, Ohio.
1892	Mackinnon, Geo. S.	Canadian Pacific	Toronto Junction, Ont.
1878	Maglenn, Jas.	Seaboard Air Line	Raleigh, N. C.
1896	Maher, P.	Ind. Ill. & Iowa	Kankakee, Ill.
1896	Mahl, F. W.	So. Pac.	Sacramento, Cal.
1895	Mallinson, E. P.	Brooklyn Elevated	2075 B'way, Brooklyn, N. Y.
1894	Manchester, A. E.	C. M. & St. P. R'y	Milwaukee, Wis.
1893	Manning, J. H.	Union Pacific	Omaha, Neb.
1896	Marden, J. W.	Fitchburg	Boston, Mass.
1890	Marshall, E. S.		Missouri Mall. Iron Co., St. Louis, Mo.
1895	Martin, J. W.	B. & O.	Bay View Station, Baltimore, Md.
1888	Maver, A. A.	Grand Trunk	Stratford, Ont.
1892	McCann, Thos.	Geo. Creek & Cum.	Cumberland, Md.
1891	McConnell, J. H.	Union Pac.	Omaha, Neb.
1896	McCormick, A.	C. R. I. & P.	Goodland, Kan.
1893	McCracken, I. E.		Erie Shops, Bradford, Pa.
1890	McCreery, Frank	C. H. & D.	Dayton, Ohio.
1892	McCuen, J. P.	C. N. O. & T. P.	Ludlow, Ky.
1891	McDonough, Jas.	Gulf, Col. & S. F.	Galveston, Tex.
1892	McDuff, Allan	B. C R. & N.	Cedar Rapids, Iowa.
1893	McElvaney, C. T.	M. K. & Tex.	Denison, Tex.

JOINED.	NAME.	ROAD.	ADDRESS.
1892	McIlwain, J. D.		12 Alpha Terrace E. E., Pittsburg, Pa.
1890	McIntosh, Wm.	Ch. & N.-Western.	Winona, Minn.
1893	McKee, G. S.	C. C. C. & St. L.	Mattoon, Ill.
1896	McLean, W. J.		Fairhaven, Wash.
1894	McMasters, Chas. J.	Benn. & Rutland	Rutland, Vt.
1896	McNabb, T.	Gt. Falls & Canada.	Lethbridge, Alberta, Can.
1890	McNaughton, Jas.	Wisconsin Central	Waukesha, Wis.
1896	McNeill, Wm. D.	Hoosac Tun. & Wil.	Readsboro, Vt.
1888	Medway, John	Fitchburg	Boston, Mass.
1895	Mellin, C. J.	Richmond Loco. Wks.,	Richmond, Va.
1892	Mertsheimer, F.	Union Pacific	Armstrong, Kan.
1887	Michael, J. B.	Southern	Knoxville, Tenn.
1883	Middleton, Harvey	B. & O.	Baltimore, Md.
1885	Millen, Thos.	Metropolitan Street R'y,	High Bridge, N. Y.
1890	Miller, Geo. A.	Florida East Coast	St. Augustine, Fla.
1896	Miller, G. W.	Erie	Elmira, N. Y.
1889	Miller, E. A.	N. Y. C. & St. L.	Conneaut, Ohio.
1890	Mills, Stott		Warwick, N. Y.
1893	Minshull, P. H.	N. Y. O. & W.	Middletown, N. Y.
1892	Minto, H. M.	L. & Nashville.	Mobile, Ala.
1888	Minton, A. B	M. & Ohio	Murphysboro, Ill.
1894	Missimer, H. M.	Lehigh & Hudson	Warwick, N. Y.
1892	Mitchell, Alva	A. T. & S. F	Ottawa, Kan.
1870	Mitchell, A.	Lehigh Valley.	Wilkesbarre, Pa.
1892	Mitchell, A. E	Erie	New York City.
1894	Mitton, W. G.	Interoceanic	Mexico, Mex.
1890	Monkhouse, H.	Chicago & Alton	Bloomington, Ill.
1888	Montgomery, Wm	Cent. of N. J	Manchester, N. J.
1890	Moore, J. H.	Erie	Buffalo, N. Y.
1895	Moraga, Anselmo	Chilian State.	Santiago, Chili.
1896	Moran, Rob't	L. & N	Bowling Green, Ky.
1887	Morris, W. S.	Ches. & Ohio	Richmond, Va.
1890	Morse, F. W.	Grand Trunk.	Montreal, Can.
1891	Mott, D. G	Panama	Colon, Colombia.
1890	Murphy, P. H.	Murphy Car Roof Co.,	East St. Louis, Ill.
1894	Nettleton, W. A.	Kan. C. Ft. S. & M.	Kansas City, Mo.
1892	Neuffer, John G.	B. & O. S.-W.	Cincinnati, Ohio.
1896	New, W. T.	Mo. Pacific	Kansas City, Mo.
1896	Neward, F. H.	Pontiac, Ox. & North'n.	Pontiac, Mich.
1896	Nicholas, J. O.	Michoacan & Pac.	Maravatio, Michoacan, Mex.
1890	Nicholls, J. Mayne.		Iquique, Chili.
1875	Noble, L. C.	A. French Spring Co.,	Pittsburg, Pa.
1896	Norsworthy, N. W.	Norfolk & Western	Crewe, Va.
1896	Nuttall, W. H.	Manistee & N.-Eastern.	Manistee, Mich.

JOINED.	NAME.	ROAD.	ADDRESS.
1890	O'Brien, John	Rich. & Petersburg	Manchester, Va.
1890	O'Herin, Wm	Mo. Kan. & Tex	Parsons, Kan.
1895	O'Leary, D	Seattle & International	Seattle, Wash.
1895	Orland, W. P	C. C. C. & St. L	Mt. Carmel, Ill.
1897	Osborne, H	Canadian Pacific	Montreal, Can.
1890	Page, H. D	Chic. & N.-Western	Baraboo, Wis.
1895	Pagenhart, C. L	Augusta Southern	Augusta, Ga.
1891	Pattee, J. O	Gr. Northern	St. Paul, Minn.
1879	Patterson, J. S		Galena Oil Co., Cincinnati, Ohio.
1885	Paxson, L. B	P. & Reading	Reading, Pa.
1891	Paxton, Thos	A. T. & S. F	Ft. Madison, Iowa.
1897	Payton, H. T	A. T. & S. F	Raton, N. M.
1897	Pease, F. J	T. St. L. & K. C	Frankfort, Ind.
1887	Peck, Peter H	C. W. I. & B	Chicago, Ill.
1897	Pflager, H. M		Pullman Palace Car Co., Chicago, Ill.
1889	Phelan, J. E		Railroad Commission, Bismarck, N. D.
1878	Pilsbury, Amos	Maine Central	Waterville, Me.
1885	Pitkin, A. J		Schenectady Loco. Wks., Schenectady, N. Y.
1874	Place, T. W	Ill. Cent	Waterloo, Iowa.
1881	Player, John	A. T. & S. F	Topeka, Kan.
1897	Pollitt, Harry	M. S. & L	Gorton, Manchester, Eng.
1893	Potter, G. L	Penn. Lines	Fort Wayne, Ind.
1897	Potton, J	Texas & Pacific	Big Springs, Tex.
1891	Prescott, C. H	Spokane Falls & Nor	Spokane Falls, Wash.
1892	Priest, A. F	Duluth, Missabe & Nor.	Duluth, Minn.
1894	Priest, Edwin	B. & A	East Albany, N. Y.
1881	Pringle, R. M		Second and Carr sts., St. Louis, Mo.
1891	Pullar, John	A. & Pac	Winslow, Ariz.
1890	Purves, T. B., Jr	B. & A	Springfield, Mass.
1887	Quackenbush, A. W	St. L. Cape G. & Ft. S	Cape Girardeau, Mo.
1888	Quayle, Robert	C. & N.-W	Chicago, Ill.
1895	Quereau, C. H	B. & M. R	Plattsmouth, Neb.
1888	Quinn, John A	Ches. & Ohio	Clifton Forge, Va.
1895	Raidler, W. P	St. L. & Hannibal	Hannibal, Mo.
1896	Rainsford, Henry J	Montana Union	Anaconda, Mont.
1890	Randolph, L. S		Balt. Elec. Refining Co., Baltimore, Md.
1892	Reading, R. B		Passaic, N. J.
1891	Rearden, Frank	Missouri Pacific	St. Louis, Mo.
1895	Redding, M. J	W. & B. R. V	Brinkley, Ark.
1888	Reed, W. T	Seaboard Air Line	Portsmouth, Va.
1890	Reid, M. M	A. & Danville	Lawrenceville, Va.
1883	Renshaw, W	Ill. Cent	Chicago, Ill.
1892	Rettew, C. E	D. & H. C	Carbondale, Pa.

JOINED.	NAME.	ROAD.	ADDRESS.
1896	Reynolds, O. H	Asso. Ed. Loco. Eng	256 Broadway, N. Y.
1887	Rhodes, G. W	C. B. & Q	Aurora, Ill.
1896	Richards, George F	Elmira, Cort. & Noth'n	Cortland, N. Y.
1889	Rickard, C. W	A. T. & S. F	Raton, N. M.
1897	Rickert, Mason	C. C. C. & St. L	Indianapolis, Ind.
1894	Riley, George N	McKeesport Connecting	McKeesport, Pa.
1882	Roberts, E. M		Atlanta, Ga.
1896	Roberts, J. W	Chic. & South-Eastern	Lebanon, Ind.
1891	Roberts, Mord	St. L. I. M. & S	Little Rock, Ark.
1885	Robertson, W. J	Central Vermont	St. Albans, Vt.
1895	Robinson, Frank	Maine Central	Bangor, Maine.
1896	Robkin, Charles	Little Rock & Mem	Argenta, Ark.
1896	Rogers, M. J	K. C. Belt	Kansas City, Mo.
1896	Rosing, W. H. V	D. & R. G	Denver, Colo.
1882	Ross, George B		Box 326, Buffalo, N. Y.
1894	Roth, Frederick	Lehigh Valley	Delano, Pa.
1892	Rotheram, T. F	New Zealand Govt	Wellington, N. Z.
1895	Royal, C. B	Seaboard Air Line	Portsmouth, Va.
1896	Rusch, Peter C	Buffalo, Roch. & Pitts	Bradford, Pa.
1890	Rutherford, Wm		Savannah, Ga,
1893	Ryan, E	Gal. H. & San A	San Antonio, Tex.
1892	Ryan, Patrick	L. & Nash	Russellville, Ky.
1891	Ryan, J. J	So. Pac	Houston, Tex.
1891	Ryder, Henry	Housatonic	Falls Village, Conn.
1892	Sague, J. E	Schenectady Loco. Wks.,	Schenectady, N. Y.
1887	Sample, N. W	D. & R. G	Denver, Colo.
1891	Sanborn, J. N	B. & N. M	Brainard, Minn.
1896	Sanderson, R. P. C	Norfolk & Western	Roanoke, Va.
1895	Sandt, E. I	Phila. & Reading	Philadelphia, Pa.
1896	Sanford, J. W	Penna	Jersey City, N. J.
1896	Santer, A	New York & Western	Lambert's Point, Va.
1874	Schlacks, Henry	Denver & R. Grande	Denver, Colo.
1891	Schreiber, P. H	Cin. N. O. & Tex. Pac	Chattanooga, Tenn.
1875	Sedgwick, E. V	Interoceanic	City of Mexico, Mex.
1896	Sehrt, H. M	Ohio Southern	Springfield, Ohio.
1869	Setchel, J. H		Cuba, N. Y.
1890	Seward, J. P	A. & B. Short Line	Annapolis, Md.
1892	Shackford, C. E	Mex. Cent	San Luis Potosi, Mex.
1868	Shaver, D. O	Penn	Pittsburg, Pa.
1891	Sheer, Jas. M		514 Seventh st., East St. Louis, Ill.
1890	Shields, J. C	Mineral Range	Hancock, Mich.
1895	Silva, Claudio de	Ferro Cent. de Brazil	Rio de Janeiro, Brazil.
1883	Sinclair, Angus		256 Broadway, New York City.
1892	Sinnott, W	B. & O	Cumberland, Md.
1896	Skinner, Calvin	Ala. Great Southern	Birmingham, Ala.

JOINED.	NAME.	ROAD.	ADDRESS.
1889	Skinner, H. M. C		88 Walnut st., Fall River, Mass.
1893	Slater, Frank	Chicago & N.-W	West Chicago, Ill.
1889	Slater, John C	Nev. Cent	Battle Mt., Nev.
1894	Slayton, C. E	Chic. Gr. Western	Oelwein, Iowa.
1889	Small, H. J	So. Pac	Sacramento, Cal.
1893	Smith, F. B	N. Y. N. H. & H	New Haven, Conn.
1896	Smith, F. C	Fitchburg	Mechanicsville, N. Y.
1890	Smith, Geo. W	A. T. & S. F	Topeka, Kan.
1894	Smith, H. C	D. & H. C	Oneonta, N. Y.
1892	Smith, John L	Buffalo, Roch. & Pitts	Du Bois, Pa.
1893	Smith, Thos	A. T. & S. F	Raton, N. M.
1891	Smith, Wm		Oak Park ave., Oak Park, Ill.
1869	Smith, W. T	Newport News & M. V.	Lexington, Ky.
1891	Soule, R. H		Roanoke, Va.
1896	Spafford, C. P	Winifrede	Winifrede, W. Va.
1897	Spragge, Jos. R	Can. Pac	McAdam Junct., N. B.
1868	Sprague, H. N		Jamestown, N. Y.
1895	Sprigg, Z. T	Union Pac	Denver, Colo.
1895	Stafford, Jas. T	St. L. I. M. & South.	Little Rock, Ark.
1893	Stalder, Abram W	F. Ft. W. & W.	Findlay, Ohio.
1890	Stamelen, F	Erie & Huron	Chatham, Ont.
1894	Steele, S. A	W. & Pitts	Weston, W. Va.
1887	Stephens, S. A		R. I. Loco. Wks., Providence, R. I.
1874	Stevens, Geo. W	L. S. & M. S	Cleveland, Ohio.
1892	Stewart, Andrew F	Ches. & Ohio	Huntington, W. Va.
1885	Stewart, O	Bangor & Aroostook	Oldtown, Maine.
1890	Stillman, H	Southern Pacific	Sacramento, Cal.
1896	Stocks, W. H	C. R. I. & P	Rock Island, Ill.
1883	Stokes, J. W	St. L. A. & T. H	East St. Louis, Ill.
1896	Stout, S. E	Phila. & Reading	Philadelphia, Pa.
1875	Strode, Jas		410 So. Main st., Elmira, N. Y.
1890	Studer, A. L	C. R. I. & P	Trenton, Mo.
1895	Stulb, W. H	C. of Ga	Augusta, Ga.
1891	Sullivan, J. J	L. & N. R. R	Tenth and Kentucky sts., Louisville, Ky.
1891	Summerskill, T. A	M. & N.-West	Portage la Prairie, Man.
1892	Sumner, Eben T	B. & M	East Cambridge, Mass.
1892	Sutherland, R. D	Boston, R. B. & Lynn.	Boston, Mass.
1868	Swanston, Wm	P. C. C. & St. L	Indianapolis, Ind.
1892	Symons, W. E	A. T. & S. F	Raton, N. M.
1894	Taft, Wm. H	B. & Albany	Boston, Mass.
1883	Tandy, H		Brooks Loco. Wks., Dunkirk, N. Y.
1896	Tawse, Robt	Ann Arbor	Owosso, Mich.
1893	Taylor, C. M	A. T. & S. F	Raton, N. M.
1895	Taylor, H. D	Lehigh Valley	Wilkesbarre, Pa.

JOINED.	NAME.	ROAD.	ADDRESS.
1896	Taylor, Jno	C. M. & St. P	Minneapolis, Minn.
1893	Taylor, Wm. H	Wilkesbarre & East	Stroudsburg, Pa.
1886	Thatcher, Thos	D. L. & W	Utica, N. Y.
1885	Thomas, C. F	Southern	Alexandria, Va.
1891	Thomas, H. T.	Det. & Mackinac	East Tawas, Mich.
1892	Thomas, J. J., Jr.	Mobile & Birmingham	Mobile, Ala.
1883	Thomas, W. H	Southern	Washington, D. C.
1890	Thompson, C. A.	Central N. J	Jersey City, N. J.
1896	Thompson, Geo	Beech Creek	Jersey Shore, Pa.
1895	Thompson, W. F	Kings Co. Elev	Brooklyn, N. Y.
1883	Thow, Wm	Government	Sydney, N. S. W.
1892	Todd, Louis C	B. & M	Lyndonville, Vt.
1892	Tomlinson, Jas. G	N. O. & N.-E	Meridian, Miss.
1897	Tomlinson, J. J	Mex. Northern	Escalon, Chihuahua, Mex.
1893	Tonge, John	M. & St. Louis	Minneapolis, Minn.
1885	Torrance, John	E. & T. H	Evansville, Ind.
1896	Tower, G. M	Fitchburg	Fitchburg, Mass.
1892	Townsend, Jos	Chic. & Alton	Bloomington, Ill.
1896	Tracy, W. L	Southern	Birmingham, Ala.
1892	Traver, W. H	Rand Drill Co., Monadnock Block	Chicago, Ill.
1883	Tregelles, Henry	Care Norton, Megaw & Co.	Rio de Janeiro, Brazil.
1892	Tremp, A. E	C. C. C. & St. L	Indianapolis, Ind.
1892	Tresize, Thos		423 North Stricker st., Baltimore, Md.
1896	Tubbs, F. E	Jcknvlle.,Tam. & K. W.	Palatka, Fla.
1890	Tuggle, S. R	Houston & Tex. Cent.	Houston, Tex.
1890	Turner, Calvin G	Phil. Wil. & Balt.	Wilmington, Del.
1889	Turner, Chas. E	B. R. & P	Rochester, N. Y.
1886	Turner, J. S	W. Va. Cent. & Pitts	Elkins, W. Va.
1890	Turner, L. H	Pitts. & L. Erie	McKees Rocks, Pa.
1886	Twombly, A. W	Old Colonv	Taunton, Mass.
1883	Twombly, Fred M	N. Y. N. H. & H	Boston, Mass.
1890	Tyrrell, Thos. H	Staten I. Rap. Transit	Whitehall st., N. Y. City.
1887	Tynan, F. F	Ferro Carriles Unidos de la Habana	Habana, Cuba.
1889	Vail, A	Western N. Y. & Pa.	Buffalo, N. Y.
1890	Van Brunt, G. E	Penna. & N.-Western	Bellwood, Pa.
1896	Van Cleve, J. R.	Great Northern	Kalispell, Mont.
1891	Vauclain, Sam'l M	Baldwin Loco. Wks.	Philadelphia, Pa.
1896	Villasenor, Alberto	Fer. Car. Acaj. Sous.	Salvador, C. A.
1892	Vogt, A. S	Penn	Altoona, Pa.
1892	Wade, R. D	Southern	Washington, D. C.
1896	Wagner, Jno. R	Del. Susq. & Schuyl	Drifton, Pa.
1892	Waitt, A. M	L. S. & M. S	Cleveland, Ohio.
1896	Walker, C. E	B. & O. S.-W.	Washington, Ind.

JOINED.	NAME.	ROAD.	ADDRESS.
1893	Walker, Henry E	Mexican Southern	Pueblo, Mex.
1891	Wallis, J. M	Pennsylvania	Williamsport, Pa.
1888	Wallis, Philip	Lehigh Valley	Easton, Pa.
1874	Walsh, Thos	L. & Nash	Howell, Ind.
1896	Walters, J. H	L. & N	Anniston, Ala.
1896	Walton, E. A	Fitchburg	Boston, Mass.
1896	Ward, C. A	K. C. & Indepen. Air L.	Kansas City, Mo.
1887	Ward, C. F	Duluth, Superior & West.	Cloquet, Minn.
1883	Warren, Beriah	T. P. & W	Peoria, Ill.
1882	Warren, W. B	T. P. & W	Peoria, Ill.
1883	Watts, Amos H	C. J. & M	Van Wert, Ohio.
1896	Waugh, L. H	G. C. & S. F	Cleburne, Tex.
1894	Weaver, Jas. N	Lehigh Valley	Sayre, Pa.
1887	Webb, F. W	L. & N. W	Crewe, England.
1892	Weiss, C. P	Erie	Hornellsville, N. Y.
1886	Weisgerber, E. L	B. & O	Mt. Clare Shops, Baltimore, Md.
1868	Wells, Reuben		Rogers Loco. Wks., Paterson, N. J.
1896	West, A. J	Tabor & Northern	Tabor, Iowa.
1880	West, G. W	N. Y. O. & W	Middletown, N. Y.
1885	White, A. M		Schenectady Loco. Wks., Schenectady, N. Y.
1894	White, E. T	B. & O	Riverside, Balto., Md.
1894	Wiggin, Chas. H	Boston & Maine	Concord, N. H.
1884	Wightman, D. A		Pitts. Loco. Wks., Allegheny, Pa.
1891	Wilcox, W. J	O. R. & S. C	Blacksburg, S. C.
1896	Williams, Alfred	Paulista	Paulista, Brazil, S. A.
1891	Williams, E. A	M. St. P. & S. S. M	Minneapolis, Minn.
1887	Wilson, G. F	C. R. I. & P	Chicago, Ill.
1896	Woodhouse, T. D	Kan. City, Pitts. & Gulf.	Pittsburg, Kan.
1896	Worswick, J. E	Ga. & Ala	Americus, Ga.
1896	Yohn, C. R	H. & B. T. Mtn	Saxton, Pa.
1895	Young, W. H	Florida So	Palatka, Fla.
1893	Young, O. de	G. H. & S. A	El Paso, Tex.

ASSOCIATE MEMBERS.

JOINED.	NAME.	ADDRESS.
1893	Baker, Geo. H	Morse Bldg., New York City.
1895	Coster, E. L.	27 William street, New York City.
1883	Dean, F. W.	55 State street, Boston, Mass.
1871	Forney, M. N.	501 Fifth avenue, New York City.
1896	Fowler, Geo. L	53 Broadway, New York City.
1880	Gordon, Alex.	Niles Tool Works, Hamilton, Ohio.
1895	Goss, W. F. M.	Purdee University, Lafayette, Ind.
1889	Hill, John A.	256 Broadway, New York City.
1893	Leeds, Hon. John H.	318 Howard avenue, New Haven, Conn.
1891	Marshall, W. H.	C. & N.-W. R'y, Chicago, Ill.
1871	Miles, F. B	Bement & Miles, Philadelphia, Pa.
1897	Moore, E. F.	Railroad Commission, Lansing, Mich.
1889	Pomeroy, L. R.	33 Wall street, New York City.
1893	Robinson, Harry P	Monadnock Bldg., Chicago, Ill.
1886	Shaw, Thos.	915 Ridge street, Philadelphia, Pa.
1889	Smith, John Y.	Doylestown, Pa.
1882	Smith, W. A	Old Colony Bldg., Chicago, Ill.
1871	Wheelock, Jerome	25 Elizabeth street, Worcester, Mass.

HONORARY MEMBERS.

JOINED.	NAME.	ROAD.	ADDRESS.
1869	Coolidge, G. A.		Charlestown, Mass.
1870	Cooper, H. L.		4644 State street, Chicago, Ill.
1870	Divine, J. F	W. & Weldon	Wilmington, N. C.
1881	Eastman, A. G.		Sutton, Que.
1868	Eddy, Wilson		Springfield, Mass.
1872	Foss, J. M.	Cent. Vermont	St. Albans, Vt.
1885	Galloway, A	C. H. & I.	Indianapolis, Ind.
1869	Graham, Chas.		401 Madison avenue, Scranton, Pa.
1875	Harding, B. R	R. G. R. & A.	Raleigh, N. C.
1870	Hodgman, S. A.		Lobdell Car Wheel Works, Wilmington, Del.
1874	Jeffery, E. T.	Denver & Rio Grande.	Denver, Colo.
1868	Johann, Jacob.		1007 South Seventh street, Springfield, Ill.
1873	Lannan, Wm.		House of Representatives, Washington, D. C.

JOINED.	NAME.	ROAD.	ADDRESS.
1871	McCrum, J. S		Kansas City, Mo.
1891	McKenna, John	I. D. & S. W	Indianapolis, Ind.
1868	Mulligan, J	Conn. River	Springfield, Mass.
1872	Philbric, J. W		Waterville, Maine.
1873	Prescott, G. H		Terre Haute, Ind.
1869	Richards, George		14 Auburn street, Roxbury, Mass.
1870	Robinson, W. A		Hamilton, Ont.
1869	Sellers, Morris		Western Union Bldg., Chicago, Ill.
1888	Sheppard, F. L	Penn	Altoona, Pa.
1872	Stearns, W. H		Springfield, Mass.
1883	Sullivan, A. W	Ill. Cent	Chicago, Ill.
1869	Thompson, John		137 Webster street, East Boston, Mass.
1870	Towne, H. A		236 First avenue, Minneapolis, Minn.
1869	White, J. L		Danville, Ill.
1870	Williams, E. H		Baldwin Loco. Works, Philadelphia, Pa.

PROCEEDINGS.

The Thirtieth Annual Convention of the American Railway Master Mechanics' Association was called to order at 9:45 A.M., on Tuesday, June 15, 1897, at the Hotel Chamberlin, Old Point Comfort, Virginia, by President Soule.

Prayer was offered by the Rev. W. F. Sheppard.

THE PRESIDENT: I now take pleasure in introducing to you, as representing the locality in which we are assembled, the officer who is second in command at Fortress Monroe, Col. Henry C. Hasbrouck. [Applause.]

COLONEL HASBROUCK: Mr. President and Gentlemen of the Association: It was the intention of Colonel Frank, commandant of the Artillery School, to be present this morning and welcome you to Old Point. Owing to his departure last night to attend a meeting of the Fortification Board in New York City, I am left temporarily in command, and the pleasant duty of bidding you welcome to Old Point, on behalf of the military, devolves upon me. The school here is for the heavy artillery branch of the service. All artillery officers of our little army take here a post-graduate course of two years in addition to the four years training they receive at West Point. There are eight batteries or companies of heavy artillery soldiers at the fort (four of these are in the barracks), and they constitute the permanent garrison of the school. In addition to those four batteries, there are also four in camp outside of the fort. These come from Washington and Baltimore, and are sent here for their annual practice. It may be interesting to you to know that you will see concentrated here at this post, during your stay, one-fourth of all the heavy artillery soldiers maintained by the general government for the defense of our whole coast, from Maine to Alaska. I again bid you welcome on behalf of the military and hope that your stay at Old Point will be pleasant and profitable. [Applause.]

THE PRESIDENT: On behalf of the entire membership, I wish to thank Colonel Hasbrouck for the welcome he has extended to us, and for the privileges which will follow it, and to assure him that we appreciate the welcome, and that we intend to avail ourselves of the privileges and to enjoy them. [Applause.]

President Soule then read the following address:

GENTLEMEN OF THE ASSOCIATION:

This is the thirtieth annual meeting of our organization, and the second which has been held at Old Point Comfort. This region, which is rich in historic associations and abounds in interesting features, is not, therefore, unfamiliar to us; we are to be congratulated on being afforded the opportunity to renew our labors and our friendships in such charming surroundings, and under circumstances so generally auspicious; and, to crown it all, we glory in the fact that our lady friends are with us in such goodly numbers. Although we are on the soil of Virginia, we are within the limits of a government reservation, which is significant and appropriate when we consider that ours is a National Association.

The reports of your Secretary and Treasurer, which will be duly presented to you, will show that the Association is in a flourishing condition; the scholarships at the Stevens Institute of Technology are not sought for as anticipated, however. The Secretary has received several inquiries from members about the examinations to the Stevens Institute to be held this month, but it is not possible to ascertain definitely whether the two scholarships which we will then become entitled to will be filled or not; nevertheless, we may properly congratulate ourselves on the general success so far achieved by the Association, and it is doubtful whether the most enthusiastic of the founders who launched this venture twenty-nine years ago could have predicted a greater degree of success than has been realized. From a membership of forty-one which was enrolled at the first regular meeting, held at Cleveland in 1868, we have grown to a body of about 620 members at this time, with every certainty of still further accessions to our ranks. We have suffered an apparent reduction of membership during the last year, but this is owing to the fact that that provision of the constitution which specifies that any member who shall be two years in arrears for annual dues, and, having been notified of the fact, shall not pay such dues within three months after such notification, shall be dropped from the rolls, has been enforced, whereas that provision had not been enforced for several years back. It is proper that the organic law of the Association should be thus applied, even if we thereby suffer an apparent reduction of membership. It is believed that ours is, today, the largest of any of the numerous railway associations in existence; all, except one, of which have been organized since the Master Mechanics' Association.

The conditions which surround us today are in most respects different from those which existed in 1868, when this Association was formed. Facts which are now accepted as commonplace truths were questioned and debated in those early days with the utmost vigor and zeal. At the first annual meeting, in 1868, the following subject was discussed: "Are steel plates preferable to iron in the construction of locomotive boilers, and if so, will the difference in strength, durability and safety justify the excess of cost of steel as compared with the cost of the best iron?"; but the tidal wave of growing opinion in favor of steel carried the committee along on its crest so that in the proceedings of the next or second annual convention, in 1869, the following is recorded: "Your committee feel warranted in deciding emphatically in favor of homogeneous steel for all fire boxes burning bituminous coal." In the same year, 1869, it was recorded of steel tires that "though at first adopted with hesitation and received into general use only within about four years, they are already in a large majority and their supersedure of all others is rapidly becoming universal." At the third annual session, in 1870, the death knell of wood as a locomotive fuel was sounded by a committee which went on record as predicting that bituminous coal then bid fair to become the standard fuel for coming time. They were not so far along in the matter of lubrication, however, for at the fourth session, in 1871, a Committee on Lubricating Oils reported that the general preference at that time for a lubricant for the machinery of the locomotives of fast passenger trains was pure lard oil, and for a cylinder lubricant, pure refined tallow.

If we were to assemble a museum of curiosities, what would attract more attention than the locomotives which were in current use at the time that this Association was established? and yet the development from the types then in use to the more perfect ones now in vogue has gone on by easy stages until we imagine that the locomotive of today is almost perfect; but why are we justified in taking to ourselves any such flattering unction when we know that thirty years from now not only our machinery, but perhaps we ourselves, may be the most conspicuous objects in a museum of mechanical curiosities.

But such success as has been achieved by the Association should be very largely credited to the wise forethought of the founders, and to those who, taking up the work after them, from time to time modified the constitution and by laws to meet altered conditions and to broaden the scope of the Association. So cleverly has this been done, that both men versed in practice and men versed in theory have been drawn into our ranks; the result, to the mutual benefit of all, being, that the practical men have learned to respect sound theory and the theoretical men have learned to respect sound practice. In this combining of the practical and the theoretical lies one of our elements of strength, and this Association is a glorious example of the fact that there is no sharp dividing line between theory and practice, but that the two are so merged into one another that the fusion is universally regarded like a happy marriage.

Since we met a year ago, there has been much activity in our chosen calling. In locomotive practice a marked tendency has been the use of higher steam pressures even in simple engines, and there are some indications that the now general practice of building simple locomotives to carry perhaps 150 pounds pressure will be superseded by an accepted practice of carrying perhaps 180 pounds pressure. By many it is believed that the pressure of maximum economy for a simple locomotive working under average conditions of service will be found to exist in the neighborhood of 180 pounds. The logical sequence of this will be that designers and builders of compound locomotives, in order to hold their own in the matter of fuel economy, as compared with simple engines, will be forced to use higher pressures than have hitherto been customary even in compound engines. The past year has been signalized by the production of a number of individual types of locomotives for passenger service, some having very large driving wheels and boilers. The piston valve is growing in favor; this may be regarded as one of the results of the tendency toward the use of higher pressures, and the necessity of having valves which are perfectly balanced. The effort to reduce weights of reciprocating parts in high-speed engines has been continued, but there is much work remaining to be done in this direction. In freight engines there is a tendency toward the use of larger cylinders and larger wheels, resulting in reduced speed of reciprocating and vibrating parts, with the incidental benefits of better steam distribution and reduced wear and tear on machinery. In the details of valve-motion gear the tendency is toward decreased lead and increased inside clearance. The general tendency toward the use of high pressures and ample steam supply in locomotive service has been reflected in the increased use of cast steel in order to lighten the parts which are susceptible of such treatment, and to permit of an increase in the size and weight of the boiler; it has also been reflected in the efforts of the manufacturers of injectors to produce boiler feeding instruments which will more perfectly adapt themselves to the wide variation of conditions which are found in the current performance of engines which are adapted to carry very high boiler pressures. These conditions are very exacting, as successful feeding instruments must give a wide range of deliveries under every possible combination of surrounding conditions. The tendency of the locomotive designer has always been to prove a machine somewhat heavier than the track will comfortably carry. In our judgment this tendency should be indulged, within safe limits, as a locomotive may be in current use for a period of perhaps fifteen years, during which time it becomes no heavier, whereas the constant tendency in track and bridge construction and maintenance is toward heavier and stronger parts and increased carrying capacity. It is true that the application of power brakes to the locomotives of most large roads has been advanced to the point where the completion of the equipment of all locomotives is within easy reach. This suggests a new era in the matter of the movement of freight trains at least, a prominent feature of which will probably be increased speed; a considerable saving in capital account will result from the greater amount of service which can thus be realized from equipment now in existence. The tonnage rating of locomotives is an accepted feature of improved railroading. Operating officers of railroads are very exacting in their demands that each and every locomotive should produce a tractive effort fully proportionate to its weight on drivers.

While we were in session at the Saratoga Convention of 1896, an English correspondent of one of our technical railroad journals wrote that two of the large English railways had brought out express engines of a size hitherto unknown, these engines being distinguished more especially by their great steam-producing capacity, and by the fact that they had 1,400 feet of heating surface. Some of our fast passenger engines which have been produced during the year have a heating surface of over 2,200 square feet, while some recent heavy freight engines have a heating surface in the neighborhood of 2,900 square feet. During the year the claim has been made that one of our modern compound passenger engines has developed work up to the unprecedented figure of 1,700 horse-power.

The compound locomotive is still in the balance, and its merits and demerits are being carefully debated and weighed. The indications are, however, that the compound engine has gained friends during the year, and that improved types have been put in service only to strengthen its hold on popular favor.

It was said long ago that extravagance in fuel consumption would be the penalty which users of locomotives would have to pay on account of the high degree of concentration in the relative arrangement of boiler and machinery which were imposed by the conditions of railroad practice. We feel no discredit, therefore, when we call attention to the fact that, as compared with stationary practice, where, in general, room is unlimited, and with marine practice where room, though limited, is more abundant than is possible in locomotive practice, nevertheless, we are but a short distance behind in the matter of fuel consumption as expressed in pounds of coal consumed per horse-power per hour; some figures representing what is believed to be the average results of recent good practice, are: For stationary plants, 1.48; for marine plants, 1.31; for locomotive service, 2.50.

In the matter of machine design as applied to tools which are commonly used in railroad shops, the tendencies have been toward types which embody a high degree of power with firmness and solidity, the whole combined with a capacity to take a great variety of work, and with an adaptability to perform as many different operations on a given piece of work as possible. When increased earnings justify the managers of railroads in improving and enlarging the equipment of machine tools in their shops, there will be found ready at hand a large variety of improved modern tools, the use of which, by economizing our shop operations, will be followed by a handsome return on the outlay required to instal them.

Among the happenings of the year, in which we have reason to feel pride, is the action of the American Association of Steel Manufacturers, in adopting the form of decimal gauge for sheet metal and wire which was recently adopted by our Association jointly with the American Society of Mechanical Engineers. This gauge is properly known as the Master Mechanics' gauge, as it was our own Association which took the initiative in advocating its adoption. In addition to this, one of our principal locomotive works has recently issued a very handsome and complete catalogue of modern locomotives, together with much valuable tabulated and statistical information, the whole being inscribed with the following legend: "This catalogue is respectfully dedicated to the American Railway Master Mechanics, whose engineering skill and devoted efforts have contributed so largely toward placing the American locomotive in the front rank of the motive power of the world." Again, one of our Western universities has announced a course of study in railway engineering, and in connection with it a series of lectures on related subjects. Out of thirteen lecturers so far announced, five are members of the Master Mechanics' Association. A marked compliment to our Association is the action of the Government, which, through the Navy Department, has courteously acceded to a suggestion made by the manufacturers of the machinery of the battle ship Texas, that she should be moored at Old Point a portion of the period covered by our convention, in order that our members, together with those of our sister Association, should have an opportunity of examining her intricate and wonderful machinery.

We separated a year ago with the hope that we were on the threshold of better times, but we now look back over the year only to realize that the hopes of railway managers in this respect have been disappointed; but the benefit which has followed this condition of things is the necessity which has been upon us for continued forced economies; in our judgment, the men in charge of the mechanical operations of our American railroads are today very much better men than they would have been had the last few years been a period of prosperity, and, if the experience of all of us has been the same as that of those with whom I have exchanged views, we are each and every one of us surprised at the economies which we have been able to effect, and each and every one of us has had the fact forced home to his convictions that railroading is, after all, a commercial problem, and that the technical features of it are only secondary and must always be subordinated to economic considerations. We are not ashamed to acknowledge that during this period we have had to yield consideration to such homely questions as "Will it Pay?" or "Is it not Good Enough?" One of the logical results of the pressure which has been applied to operating officers, even to those in charge of sub departments, is that there has been a general effort to obtain and keep in shape for current reference all kinds of statistical information which reflects the results of operating. A system of reports and records, if carefully devised and if reduced to such shape as to involve a minimum of labor on the part of those who have to currently prepare and handle them, is, undoubtedly, of the greatest value as a means of judging results already reached, and as an aid to such further economies as may be necessary in order to secure still better results.

To our mind one of the greatest difficulties in railroad practice is to ascertain facts; in studying a problem which involves a knowledge of the operations or practices of railroad employes scattered over a wide territory, the most difficult thing of all is to secure a correct idea of facts as they exist. If the facts can be obtained and if they can be relied upon as facts, any operating officer who has good judgment can, in general, draw correct inferences and reach proper conclusions and can take such necessary action as may be warranted by the facts, in order to secure improved results. I would emphasize the importance of great care, on the part of those sub-officers of railroads who are in close contact with the work and the force, in responding to inquiries from superior officers, if those inquiries involve a statement of facts. This difficulty of getting facts is illustrated, in a different way, however, by the statement recently published in one of the leading technical journals of England, and reprinted in one of our own railroad papers, to the effect that while the average life of an English locomotive is about forty years, that of an American locomotive is but seven or eight years.

The railroad clubs have continued to do good work during the year; many of the subjects discussed have related to practical questions of operating, this being another indication of the fact that the continued business depression has forced home to our convictions the importance of giving first consideration to all the economical problems of railroading. As an evidence that history repeats itself, we may refer to the fact that although the question of long runs for locomotives was the subject of a committee report before this Association in 1877, it has also been the subject of a committee report and discussion before one of our railroad clubs in this year 1897. It is an undoubted fact that the railroad clubs are the first to thresh the wheat, with the result that the reports and discussions at the annual conventions of our own and our sister Association may be, and are, reduced to a smaller compass and to a narrower space of time than if this preparatory work was not done by the railroad clubs. If it is conceded that such is the case, I think that we then ought to seriously consider whether we cannot secure joint action on the part of the Master Car Builders' Association and the Master Mechanics' Association to the effect that the time covered by the conventions of these two Associations should be brought within the limits of a single week. Railroad managers by training and temperament have a habit of expecting and exacting the largest measure of results from a given expenditure of time, and, although the results from these conventions are highly creditable, yet there is undoubtedly an undercurrent of feeling among railroad managers that the same results could be achieved in a smaller compass of time. If the membership in general becomes convinced that such a feeling does exist in fact, it would be the part of prudence to anticipate any open expression of it, and to so modify the working schedule of our annual conventions that the total amount of time required to attend the conventions of both associations need not exceed a single week.

With a membership of nearly 625 it would be strange indeed if a twelvemonth could pass with the membership intact. This year we have lost five members by death. They were: T. Inglis, S. A. Sheppard, W. G. Taber, D. L. Barnes and M. S. Webb. We are sure that you will direct the preparation of memorials of the lives of these worthy members.

At this convention reports are expected from eleven committees; many of the subjects will invite extended discussion. Of the eleven committees which are scheduled to report at this convention, five were continued from the convention of 1896, while six committees were appointed subsequent to that time. It seems to have been a tradition passed along from president to president that the proper basis for forming committees was to have different sections of the country represented on them; the supposed advantage of this practice being that the membership of the committees would reflect the differences of condition and practice which existed in different parts of the country. According to general observation, however, it has been very difficult for committees thus made up to get together, the result being that the chairman has practically been in most such cases a committee of one who collected the data, compiled the results, formulated the report and asked the concurrence of his associates. I perhaps owe the members an apology for having, without specific authority, deviated from this practice. The six committees which it was my privilege to appoint have been made up on what might be called a territorial basis, the selection of members on each of these six committees being, in general, such that they could all reach some central and available meeting-point by a journey of twelve hours or less. We trust that this method of forming the committees has resulted in the members of each committee having met and worked jointly in the matter of the preparation of their reports.

As the use of electricity as a motive power is increasing, and as the great majority of our members have not been schooled in the applications of electricity as a means of propulsion, I would advise the appointment of a committee to report on the state of the art at the convention of 1898. Such a report would be largely educational in its influence on the members, and would be appreciated by them.

At the proper stage of our business, you will be called upon to give your verdict on two amendments to the constitution, which were proposed at the convention of 1896.

I now invite your attention to the regular business of the thirtieth annual convention, and ask your co operation in disposing of it with promptness.

THE PRESIDENT: It is customary at this stage of our proceedings to take a recess of a few moments to enable visitors, who do not desire to remain longer, to withdraw. We will therefore take a short recess.

[A recess of five minutes was then taken.]

THE PRESIDENT: I have to remind the members that their dues may be paid to the Treasurer, on my left, at any time during the session, or between and after sessions may be paid to the Treasurer or Secretary in the room of the Executive Committee across the hall. I also wish to state that the form in which the roll call has been taken at recent meetings is by cards, which are placed on the table at the left. It is desired that every member who attends any of the sessions should fill out one of those cards with his name and should deposit it in the box provided for that purpose; one card for each member for the entire convention. It is not necessary for any member to record his presence more than once.

The following members were present:

Aiken, C. L.
Aldcorn, Thomas.
Allen, G. S.
Arp, W. C.
Atkinson, R.
Austin, W. L.
Barnett, J. Davis.
Barr, J. N.
Bartlett, Henry.
Battye, John E.
Bean, John.
Bechhold, H. G.
Beltz, A. J.
Bisset, John.
Blackall, R. C.
Blackwell, Charles.
Boon, J. M.
Bond, I.
Bowles, C. K.
Bradeen, A. A.
Bradeen, J. O.
Bradley, W. F.
Branch, George E.
Brangs, P. H.
Briggs, D. D.
Brown, David.
Brown, W. A.
Browne, T. R.
Bryant, J. T.
Bushnell, R. W.
Butcher, George W.
Chase, F. A.
Chambers, John S.
Clark, Isaac W.
Cleaver, F. C.
Clifford, C. J.
Cloud, John W.
Cockfield, Joseph.
Cole, T. J.
Cory, C. H.
Cullinan, J.
Cushing, G. W.
Davis, Ed. E.
Deems, J. F.
Delaney, H.
Delaney, Chester A.
Doebler, Charles H.
Drury, Michael J.
Elvin, A. G.
Ferry, F. J.
Foller, P. P.
Forney, M. N.
Forsyth, William.
Foster, W. A.
Fowler, George L.
Fuller, C. E.
Gaines, F. F.
Galbraith, R. M.
Gardner, Addison.
Garstang, William.
Gentry, T. W.
Gibbs, A. W.
Gibbs, George.
Gillis, H. A.
Glaser, J.
Gordon, H. D.
Goss, W. F. M.
Graham, J. A.
Greenwood, Alfred W.
Hatswell, T. J.
Hatswell, T J., Jr.
Haughn, J. A.
Haskell, B.
Hawksworth, D.
Heers, L. B.
Henderson, G. R.
Hennessey, T. J.
Hepburn, G. W.
Herr, Edwin M.
Hibbard, H. Wade.
Higgins, S.
Hill, Rufus.
Holman, W. L.
Hudson, E. E.
Humphrey, A. L.
Hyndman, F. T.
Inge, T. S.
Jennings, William.
Joughins, G. R.
Keegan, James A.
Keegan, James E.
Kells, Willard.
Kenney, George W.
Killen, W. E.
Lang, V. B.
Lawler, F. M.

Lawes, T. A.
Lawrence, John L.
Leach, H. L.
Lee, C. W.
Leeds, Pulaski.
Lewis, William H.
MacKenzie, John.
Maher, P.
Mallinson, E. P.
Manning, J. H.
Marshall, E. S.
McConnell, J. H.
McCreery, Frank.
McIntosh, William.
McNaughton, James.
Medway, John.
Mellin, C. J.
Michael, J. B.
Miller, George A.
Miller, G. W.
Miller, E. A.
Minshull, P. H.
Mitchell, A. E.
Montgomery, William.
Moore, J. H.
Moore, E. T.
Morris, W. S.
Nettleton, W. A.
Neuffer, John G.
Noble, L. C.
Nuttall, W. H.
O'Brien, John.
O'Herin, William.
Owens, W. H.
Payton, Henry T.
Pease, F. J.
Peck, Peter H.
Pflager, H. M.
Pomeroy, L. R.
Prescott, C. H.
Purves, T. B., Jr.
Quayle, Robert.
Quereau, C. H.
Quinn, John A.
Reid, M. M.
Rettew, C. E.
Reynolds, O. H.
Rickert, Mason.
Riley, George N.
Roberts, E. M.
Roberts, J. W.
Royal, C. B.
Ryan, J. J.
Sague, J. E.
Schlacks, Henry.
Shaver, D. O.
Sinclair, Angus.
Small, H. J.
Smith, F. C.
Smith, W. T.
Soule, R. H.
Spragge, Joseph R.
Sprague, H. N.
Steele, S. A.
Stewart, Andrew F.
Stewart, O.
Stout, S. E.
Summerskill, T. A.
Sutherland, R. D.
Swanston, William.
Tandy, H.
Taylor, John.
Thomas, C. F.
Thomas, J. J., Jr.
Thompson, George.
Thompson, W. F.
Tonge, John.
Traver, W. H.
Tuggle, S. R.
Turner, J. S.
Tyrrell, Thomas H.
Vauclain, Samuel M.
Wagner, John R.
Waitt, A. M.
Wallis, Phillip.
Warren, W. B.
West, A. T.
West, G. W.
White, A. M.
Wilson, G. F.

The President: Next in order is action on the minutes of the last meeting. You are aware that the minutes of the last meeting are in print and have been generally distributed. What is your pleasure in regard to them?

Mr. Peck: I move they be adopted as printed.

The motion was carried.

The President: Gentlemen, please give attention now to the report of the Secretary.

Secretary Cloud read his annual report, as follows:

SECRETARY'S REPORT.

At the date of the last convention the membership of the Association was as follows:

Active members	615
Honorary members	24
Associate members	18
Total	657

Since that date four active members and one associate member have died, two active members have been elected honorary members, and seven active members have resigned. Fifty-nine active and one associate member have been dropped for non-payment of dues. One member has been elected an associate member. During this time thirty-three new members have joined the Association, making a roll at the present time as follows:

Active members	576
Honorary members	26
Associate members	17
Total	619

The members who have died during the year are as follows:

T. Inglis, Tyler, Tex.; S. A. Sheppard, Carabelle, Fla.; W. G. Taber, Dunkirk, N. Y.; D. L. Barnes, Chicago, Ill.; M. S. Webb, Phœnix, Ariz.

The cash collected by the Secretary since the date of the last report and up to May 29, 1897, the date of closing the books preparatory to this report, is as follows:

To dues collected from members	$3,165.00
“ Sale of Proceedings, Subscription to Printing Fund	1,060.30
“ “ “ “ Miscellaneous	78.20
“ Interest on Bank Balances	2 52
Total receipts	$4,306.02

The disbursements by the Secretary during the same time have been as follows:

By Paid Expressage	$ 10.70
“ “ Discount	18.57
“ “ Stamps and Stamped Envelopes	260.59
“ “ Office Stationery, Supplies, etc	41.41
“ “ Telegrams	10.94
“ “ Expenses moving reports, etc., from New York	89.20
“ “ Printing	1,457.65
“ “ Electros, zinc cuts, etc	181.01
“ “ Salary	1,200.00
“ “ Paid Treasurer, at Convention, June, 1896	860.00
“ “ Balance paid Treasurer, at Convention, June, 1897	175.95
Total disbursements	$4,306.02

It will be seen that there are no funds belonging to the Association now in the hands of the Secretary. There are no unpaid bills against the Association, nor any outstanding accounts unpaid excepting the cost of preparing two reports for this convention, which were not ready at the date of closing the accounts.

The arrears of unpaid dues aggregate $1,340.

The son of one member has taken a scholarship at the Stevens Institute of Technology since the last report, and other members have been furnished with the necessary information for their sons to take the June examination for entrance next fall. It is not known whether any of these will actually take the examinations or not.

Respectfully submitted,

JNO. W. CLOUD,
Secretary.

May 29, 1897.

AMERICAN RAILWAY MASTER MECHANICS' ASSOCIATION.

OFFICE OF SECRETARY.

DETAILS OF DUES COLLECTED FROM MEMBERS.

1896.			
June	22	G. S. Allen	$ 5.00
"	22	R. Atkinson	5.00
"	22	W. L. Austin	5.00
"	22	S. T. Balkam	5.00
"	22	Charles H. Barnes	5.00
"	22	John E. Battye	5.00
"	22	A. J. Beltz	5.00
"	22	A. E. Benson	5.00
"	22	John Bisset	5.00
"	22	R. C. Blackall	5.00
"	22	I. Bond	5.00
"	22	J. M. Boon	5.00
"	22	G. E. Branch	5.00
"	22	W. H. Brehm	5.00
"	22	R. H. Briggs	5.00
"	22	George D. Brooke	10.00
"	22	David Brown	5.00
"	22	W. A. Brown	10.00
"	22	J. T. Bryant	5.00
"	22	C. H. Burns	5.00
"	22	G. W. Butcher	5.00
"	22	P. H. Brangs	5.00
"	22	T. L. Chapman	20.00
"	22	I. W. Clark	5.00
"	22	C. J. Clifford	5.00
"	22	J. G. Clifford	5.00
		Carried forward....	$155.00
		Brought forward...	$155.00
June	22	J. M. Coale	5.00
"	22	Joseph Cockfield	5.00
"	22	William Cockfield	5.00
"	22	J. J. Conolly	5.00
"	22	I. Conroe	5.00
"	22	E. L. Coster	5.00
"	22	G. W. Cushing	5.00
"	22	E. E. Davis	5.00
"	22	W. J. Davis	5.00
"	22	S. K. Dickerson	5.00
"	22	George Donahue	5.00
"	22	M. J. Drury	5.00
"	22	T. G. Duncan	5.00
"	22	H. Delaney	5.00
"	22	John Ellis	5.00
"	22	R. English	5.00
"	22	W. A. Foster	5.00
"	22	C. E. Fuller	5.00
"	22	William Fuller	5.00
"	22	R. M. Galbraith	5.00
"	22	William Garstang	5.00
"	22	T. W. Gentry	5.00
"	22	W. F. M. Goss	5.00
"	22	Charles Graham, Jr.	5.00
"	22	J. A. Graham	5.00
"	22	A. S. Grant	5.00
		Carried forward....	$285.00

	Brought forward..	$285.00
June 22	Wilbur Green......	5.00
“ 22	E. W. Harris......	5.00
“ 22	B. Haskell........	5.00
“ 22	T. J. Hatswell.....	5.00
“ 22	G. R. Henderson...	5.00
“ 22	E. M. Herr.......	5.00
“ 22	Rufus Hill........	5 00
“ 22	W. L. Holman.....	5.00
“ 22	John C. Homer ...	5.00
“ 22	C. E. Hudson......	5.00
“ 22	W. H. Hudson....	5.00
“ 22	P. Hyndman......	5.00
“ 22	L. B. Heers.......	5.00
“ 22	T. Inglis..........	10.00
“ 22	William Jennings...	10.00
“ 22	G. R. Joughins....	5.00
“ 22	James E. Keegan..	5.00
“ 22	G. W. Kenney.....	5.00
“ 22	V. B. Lang........	5.00
“ 22	W. Lavery........	5.00
“ 22	T. A. Lawes.......	15.00
“ 22	H. L. Leach.......	5.00
“ 22	C. W. Lee........	5.00
“ 22	C. C. Leech.......	5.00
“ 22	John H. Leeds.....	5.00
“ 22	Pulaski Leeds.....	5.00
“ 22	W.H.Lewis,D.L.& W	5.00
“ 22	W.H.Lewis,C.B.& N	5.00
“ 22	P. T. Lonergan....	5.00
“ 22	P. Maher.........	5.00
“ 22	John Mackenzie....	5.00
“ 22	J. H. McConnell...	5.00
“ 22	James McDonough.	5.00
“ 22	Allan McDuft......	5.00
“ 22	William McIntosh..	5.00
“ 22	C. J. McMasters....	5.00
“ 22	James McNaughton.	5.00
“ 22	James Maglenn....	5.00
“ 22	E. P. Mallinson....	5.00
“ 22	J. H. Manning.....	5.00
“ 22	E. S. Marshall.....	10.00
“ 22	W. H. Marshall....	15.00
“ 22	F. P. Martin.......	5.00
“ 22	E. A. Miller.......	5.00
	Carried forward..	$540.00

	Brought forward...	$540.00
June 22	Stott Mills.........	5.00
“ 22	P. H. Minshull	5.00
“ 22	H. M. Minto......	5.00
“ 22	Alex. Mitchell.....	5.00
“ 22	H. Monkhouse.....	5.00
“ 22	J. H. Moore.......	5.00
“ 22	J. G. Neuffer......	5.00
“ 22	W. T. New.......	10.00
“ 22	L. C. Noble.......	5.00
“ 22	W. A. Nuttall......	5.00
“ 22	F. H. Neward.....	5.00
“ 22	W. O'Herin.......	5.00
“ 22	W. H. Owens.....	5.00
“ 22	P. H. Peck........	5.00
“ 22	Amos Pilsbury.....	5.00
“ 22	John Player........	15.00
“ 22	Edwin Priest......	5.00
“ 22	T. B. Purves, Jr....	5.00
“ 22	Robert Quayle.....	5.00
“ 22	C. H. Quereau.....	5.00
“ 22	H. J. Rainsford....	5.00
“ 22	W. J. Redding.....	5.00
“ 22	M. M. Reid.......	5.00
“ 22	C. E. Rettew......	5.00
“ 22	George N. Riley....	5.00
“ 22	Mord Roberts......	5.00
“ 22	Fred. Roth........	5.00
“ 22	E. Ryan..........	5.00
“ 22	George F. Richards.	5.00
“ 22	J. E. Sague.......	5.00
“ 22	P. H. Schreiber....	5.00
“ 22	E. E. Sendt.......	5.00
“ 22	J. H. Setchel......	5.00
“ 22	J. P. Seward.......	5.00
“ 22	J. P. Seward......	5 00
“ 22	H. J. Small.......	5.00
“ 22	F. C. Smith.......	5.00
“ 22	John Y. Smith.....	5.00
“ 22	William Smith.....	5.00
“ 22	W. T. Smith.......	10.00
“ 22	R. H. Soule.......	5.00
“ 22	James T. Stafford...	10.00
“ 22	O. Stewart........	5.00
“ 22	S. E. Stout........	10.00
	Carried forward...	$790.00

		Brought forward...	$790.00
June	22	R. D. Sutherland...	5.00
"	22	William Swanston..	5.00
"	22	W. E. Symons.....	5.00
"	22	W. H. Stocks......	5.00
"	22	J. W. Sanford.....	5.00
"	22	W. G. Taber......	5.00
"	22	W. H. Taft......	5.00
"	22	H. Tandy.........	5.00
"	22	Robert Tawse......	5.00
"	22	J. J. Thomas, Jr....	5.00
"	22	C. F. Thomas......	5.00
"	22	W. H. Thomas....	5.00
"	22	George Thompson..	5.00
"	22	W. T. Thompson..	5.00
"	22	W. H. Traver.....	5.00
"	22	F. E. Tubbs.......	5.00
"	22	S. R. Tuggle......	5.00
"	22	C. G. Turner......	5.00
"	22	J. S. Turner.......	5.00
"	22	T. H. Tyrrell......	5.00
"	22	A. Vail...........	5.00
"	22	G. E. Van Brunt....	5.00
"	22	S. L. Vauclain.....	5.00
"	22	R. D. Wade.......	15.00
"	22	A. M. Waitt.......	5.00
"	22	W. B. Warren.....	5.00
"	22	J. N. Weaver......	5.00
"	22	C. P. Weiss........	5.00
"	22	Reuben Wells......	5.00
"	22	A. T. West........	5.00
"	22	P. M. McNeill.....	5.00
"	22	G. W. Miller......	5.00
"	22	George F. Richards.	5.00
"	22	Willard Kells......	5.00
"	22	C. E. Walker......	5.00
"	22	J. W. Marden......	5.00
"	22	A. Hanglin........	5.00
"	22	H. M. Sehrt.......	5.00
"	22	John Taylor.......	5.00
"	22	John Howard......	5.00
"	22	T. S. Inge........	5.00
"	22	F. J. Cole........	5.00
"	22	P. T. Bancroft.....	5.00
"	22	C. Robkin........	5.00
		Carried forward....	$1,020.00

		Brought forward...	$1,020.00
June	22	G. M. Tower......	5.00
July	13	John W. Cloud.....	5.00
"	14	W. C. Arp........	5.00
"	14	J. L. Brown.......	5.00
"	14	A. A. Daniels.....	5.00
"	14	F. H. Dehm......	5.00
"	14	N. W. Norsworth..	5.00
"	14	J. B. Barnes.......	5.00
"	15	T. S. Lloyd.......	5.00
"	15	C. H. Howard.....	5.00
"	15	W. J. McLean.....	5.00
"	15	W. J. Hemphill....	5.00
"	15	J. N. Barr.........	5.00
"	15	M. L. Hinman.....	5.00
"	15	R. J. Gross........	5.00
"	15	H. N. Sprague.....	5.00
"	15	J. Hainen.........	5.00
"	16	J. S. Chambers.....	5.00
"	16	J. B. Johnson......	5.00
"	16	John J. Ellis.......	5.00
"	16	Harry P. Robinson..	15.00
"	16	Lewis Kistler......	5.00
"	16	D. O. Shaver......	5.00
"	16	R. Moran.........	5.00
"	16	W. A. Smith.......	5.00
"	17	J. C. Shields......	5.00
"	17	Thomas Shaw.....	5.00
"	17	L. B. Paxson.....	5.00
"	17	A. B. Johnson......	5.00
"	17	W. S. Morris......	5.00
"	17	Thomas Millen.....	15.00
"	17	Jerome Wheelock..	5.00
"	17	Phillip Wallis......	5.00
"	17	G. W. Rhodes.....	5.00
"	17	John Gill..........	5.00
"	18	D. L. Barnes......	5.00
"	18	A. H. Watts......	5.00
"	18	W. H. V. Rosing..	5.00
"	18	B. Warren........	5.00
"	18	John A. Hill.......	5.00
"	18	Angus Sinclair.....	5.00
"	18	A. Beckert......	5.00
"	20	W. H. Taylor......	5.00
"	20	H. S. Hayward....	5.00
		Carried forward...	$1,260.00

		Brought forward	$1,260.00
July	20	W. F. Dixon	5.00
“	20	A. Derby	5.00
“	20	H. T. Thomas	5.00
“	20	D. A. Wightman	5.00
“	20	C. W. Rickard	5.00
“	20	J. R. Garrick	5.00
“	20	James Carr	5.00
“	20	Robert Gray	5.00
“	20	W. J. Wilcox	5.00
“	21	R. C. Esson	5.00
“	21	D. J. Justice	5.00
“	22	Z. T. Sprigg	5.00
“	22	G. B. Ross	5.00
“	22	G. L. Potter	5.00
“	23	P. H. Murphy	5.00
“	23	J. E. Keegan	5.00
“	23	G. W. Buck	5.00
“	24	J. R. Van Cleve	5.00
“	25	J. M. Keith	5.00
“	25	George James	5.00
“	25	A. E. Mitchell	5.00
“	25	P. C. Rusch	5.00
“	25	J. M. Wallis	5.00
“	27	S. Higgins	5.00
“	27	P. P. Foller	5.00
“	27	W. S. Hancock	5.00
“	27	F. W. Johnstone	5.00
“	27	L. H. Waugh	5.00
“	28	A. T. Pitkin	5.00
“	29	Henry Bartlett	5.00
“	29	O. H. Reynolds	10.00
“	29	G. Knapp	5.00
“	30	D. Hawksworth	5.00
“	30	D. O'Leary	5.00
“	30	W. A. Nettleton	5.00
“	30	J. W. Addis	5.00
“	31	R. P. C. Sanderson	5.00
Aug.	1	L. M. Butler	5.00
“	1	J. W. Hall	5.00
“	1	I. E. McCracken	5.00
“	3	C. M. Babcock	5.00
“	3	H. M. C. Skinner	5.00
“	3	John Kirk	5.00
“	3	W. L. Gilmore	5.00
		Carried forward	$1,485.00
		Brought forward	$1,485.00
Aug.	3	F. D. Casanave	5.00
“	3	M. D. Brown	5.00
“	4	Oscar Antz	5.00
“	4	James Fitzmorris	5.00
“	5	E. W. Knapp	5.00
“	5	J. B. Michael	5.00
“	5	J. J. Casey	10.00
“	6	C. Lindstrom	5.00
“	7	John Hopwood	5.00
“	7	C. E. Shackford	5.00
“	8	Henry Tregelles	10.00
“	8	Clem Hackney	5.00
“	12	E. L. Weisgerber	5.00
“	12	Henry Elliott	5.00
“	13	G. L. Dickson	5.00
“	13	James Cullen	5.00
“	15	John R. Wagner	5.00
“	15	J. W. Roberts	5.00
“	17	John Tonge	5.00
“	18	F. W. Mahl	5.00
“	18	A. M. White	5.00
“	19	S. A. Sheppard	5.00
“	21	A. McCormick	5.00
“	21	Frank Bruce	5.00
“	22	J. Davis Barnett	5.00
“	22	J. M. Davies	5.00
“	25	Q. Lamplugh	5.00
“	27	Henry Schlacks	5.00
“	27	E. Bouchard	5.00
“	27	J. R. Groves	5.00
“	29	M. N. Forney	5.00
Sept.	1	William Renshaw	5.00
“	3	F. W. Dean	5.00
“	4	A. J. Cromwell	5.00
“	4	John S. Cook	5.00
“	4	D. McLean	5.00
“	4	J. L. Greatsinger	5.00
“	4	H. S. Bryan	5.00
“	9	John Harrigan	5.00
“	9	R. W. Bushnell	5.00
“	9	A. W. Twombly	5.00
“	9	Allen Cooke	5.00
“	9	P. E. Garrison	5.00
“	14	J. F. Dunn	5.00
		Carried forward	$1,715.00

		Brought forward...	$1,715.00
Sept.	14	F. M. Twombly....	5.00
"	16	J. G. Beaumont	5.00
"	19	F. B. Miles........	5.00
"	22	A. Santer	5.00
"	23	Dr. Claride Silva...	5.00
"	25	Tracy Lyon	5.00
"	26	F. C. Cleaver......	5.00
"	28	A. W. Greenwood..	5.00
"	28	C. J. Mellin	10.00
"	28	F. T. Rotheram....	5.00
"	30	J. O. Nicholas	5.00
Oct.	3	Thomas Downing..	5.00
"	3	F. W. Webb.......	5.00
"	5	Harry Pollitt	5.00
"	6	T. W. Heintzleman.	5.00
"	7	John Pullar........	10.00
"	8	A. A. Bradeen	5.00
"	9	J. J. Ryan	5.00
"	10	J. D. Campbell	5.00
"	10	G. F. Wilson	5.00
"	10	W. W. Atterbury...	5.00
"	15	John Harrison	10.00
"	15	Joseph Lythgoe	5.00
"	16	M. J. Rogers	5.00
"	16	J. B. Glover	5.00
"	17	C. M. Taylor	5.00
"	17	R. J. Callendar	5.00
"	19	T. Paxton.........	5.00
"	20	W. I. Cooke.......	5.00
"	20	Amos Gould.......	5.00
"	21	H. Wade Hibbard..	5.00
"	24	Charles DeGress ...	5.00
"	26	William Forsyth....	5.00
"	26	A. Beattie.........	5.00
"	29	W. Cross..........	5.00
Nov.	2	C. H. Prescott	5.00
"	4	T. W. Place.......	5.00
"	4	J. L. Lawrence	5.00
"	9	W. Augustus	5.00
"	9	A. W. Belcher.....	5.00
"	11	A. R. Barrow......	10.00
"	16	C. B. Hogsett......	5.00
"	18	F. Hedley.........	10.00
"	21	John Medway	5.00
		Carried forward...	$1,960.00

		Brought forward ..	$1,960.00
Nov.	21	John M. Hurst.....	5.00
"	23	James Collinson....	5.00
"	23	A. Villesenor	10.00
"	24	James Strode	5.00
Dec.	2	Thomas Tresize....	5.00
"	3	John C. Glass......	15.00
"	4	Joseph Townsend...	5.00
"	4	Frank Rearden.....	10.00
"	5	W. H. Harrison....	5.00
"	5	John Foulk........	5.00
"	5	F. J. Ferry........	5.00
"	5	Pat Ryan..........	5.00
"	7	A. B. Minton	5.00
"	7	J. L. Driscoll	5.00
"	7	George W. Smith...	5.00
"	7	A. W. Stolder	10.00
"	8	James W. Hill.....	10.00
"	8	George Gregory	5.00
"	9	J. H. Walters	10.00
"	9	J. P. McCuen......	5.00
"	9	John Torrence	5.00
"	9	David Clark.......	5.00
"	9	W. L. Hoffecker...	5.00
"	9	George Gibbs	5.00
"	10	E. A. Walton......	5.00
"	10	A. E. Manchester ..	5.00
"	10	W. H. Stearns	5.00
"	10	George W. West....	5.00
"	10	A. G. Leonard.....	5.00
"	10	Alex Gordon.......	5.00
"	11	C. R. Yohn	5.00
"	11	E. LaLime........	5.00
"	11	W. W. Reynolds ...	10.00
"	11	I. N. Kulbach......	5.00
"	11	A. C. Hinckley	5.00
"	12	D. H. Dotterer.....	5.00
"	12	F. B. Griffith	5.00
"	12	James Macbeth	5.00
"	14	N. W. Sample	5.00
"	15	R. E. French	5.00
"	15	T. E. Butterly	5.00
"	15	F. Mertsheimer	5.00
"	16	George S. Mackinnon	5.00
"	16	G. W. Gage	5.00
		Carried forward ..	$2,220.00

		Brought forward...	$2,220.00
Dec.	16	A. L. Studor	5.00
“	16	J. H. Buckalew	5.00
“	18	D. G. Mott	5.00
“	18	A. Fenwick	5.00
“	19	G. A. Ferguson	5.00
“	19	E. A. Williams	5.00
“	21	Alva Mitchell	5.00
“	21	William Hassman	5.00
“	21	W. P. Orland	5.00
“	23	William Kelly	5.00
“	26	John Hewitt	5.00
“	28	C. H. Cory	5.00
“	30	H. D. Gordon	5.00
“	30	James Cullinan	5.00
“	30	J. H. Berry	10.00
“	30	S. P. Bush	5.00
“	31	H. Middleton	10.00
“	31	F. R. F. Brown	5.00
1897.			
Jan.	2	A. S. Vogt	5.00
“	2	William Buchanan	5.00
“	2	T. E. Adams	5.00
“	2	George A. Miller	5.00
“	4	F. B. Smith	5.00
“	4	J. O. Bradeen	5.00
“	4	William Rutherford	25.00
“	5	G. W. Stevens	5.00
“	6	J. G. Tomlinson	5.00
“	7	T. A. Foque	5.00
“	11	H. E. Walker	5.00
“	14	H. A. Child	5.00
“	14	Frank Slater	5.00
“	15	C. E. Slayton	5.00
“	15	Wm. Montgomery	10.00
“	15	George A. Hancock	10.00
“	18	J. J. Tomlinson	5.00
“	19	F. Hufsmith	15.00
“	20	J. C. Bradford	5.00
“	20	William Sinnott	5.00
“	21	E. W. Jerome	5.00
“	25	R. M. Pringle	5.00
“	25	Calvin Skinner	5.00
“	28	C. A. Thompson	10.00
Feb.	1	J. N. Sanborn	5.00
		Carried forward...	$2,490.00

		Brought forward...	$2,490.00
Feb.	1	C. A. Thompson	5.00
“	5	J. E. Worswick	5.00
“	5	F. W. Morse	10.00
“	11	F. L. Wanklyn	15.00
“	12	James Hardie	10.00
“	13	F. J. Leigh	5.00
“	15	John O'Brien	5.00
“	15	John Quinn	10.00
“	15	L. R. Pomeroy	15.00
“	15	A. V. Macdonald	5.00
“	18	M. K. Barnum	5.00
“	23	Thomas McCann	10.00
“	27	J. J. Sullivan	10.00
March	1	T. McNabb	5.00
“	1	William Cockfield	5.00
“	3	John Fould	10.00
“	4	Anselmo Maraga	10.00
“	4	P. A. Logan	10.00
“	5	H. G. Bechhold	5.00
“	8	N. M. George	5.00
“	9	H. Stillman	10.00
“	20	T. R. Browne	5.00
“	20	Z. T. Brantner	5.00
“	22	W. I. Cooke	5.00
“	24	E. Chamberlin	10.00
“	25	H. A. Gillis	15.00
“	25	John Campbell	5.00
“	25	T. A. Fraser	5.00
“	27	Joseph Billingham	10.00
“	29	C. F. Lape	5.00
“	29	C. E. Turner	5.00
“	29	William Hassman	5.00
April	1	A. Williams	5.00
“	6	L. R. Johnson	15.00
“	7	T. A. Summerskill	15.00
“	7	Thomas L. Chubb	5.00
“	7	George N. Riley	5.00
“	9	James Hinchey	5.00
“	12	G. P. Fisher	5.00
“	13	George Lindoff	5.00
“	13	J. L. Smith	5.00
“	16	O. H. Jackson	20.00
“	19	E. M. Hedley	15.00
“	19	J. I. Kinsey	5.00
		Carried forward...	$2,840.00

	Brought forward	$2,840.00
April 22	W. H. Young	10.00
" 23	George L. Fowler	5.00
" 23	R. B. Reading	5.00
" 23	J. M. Sheer	5.00
" 26	A. A. Maver	15.00
" 27	A. E. Tremp	10.00
" 29	S. B. Crawford	10.00
May 3	J. S. Patterson	20.00
" 3	M. T. Carson	5.00
" 3	J. M. Dow	5.00
" 4	L. H. Turner	10.00
" 5	C. H. De Witt	5.00
" 6	J. W. Stokes	15.00
" 8	T. Carmody	5.00
" 10	E. T. White	10.00
" 11	J. C. Slater	20.00
" 11	C. A. Ward	10.00
" 12	Frank McCreery	10.00
	Carried forward	$3,015.00

	Brought forward	$3,015.00
May 13	F. G. Brownell	10.00
" 13	A. W. Ball	15.00
" 13	Charles Blackwell	5.00
" 14	J. P. McCuen	5.00
" 15	E. V. Sedgwick	15.00
" 15	Angus Brown	15.00
" 15	W. F. Bradley	5.00
" 17	H. W. English	15.00
" 20	A. Adams	5.00
" 21	Thomas Aldcorn	10.00
" 24	C. T. McElvaney	5.00
" 24	F. A. Given	10.00
" 25	J. F. Deems	5.00
" 26	C. F. Ward	5.00
" 26	P. H. Schreiber	5.00
" 27	Thomas Paxton	5.00
" 28	J. O. Pattee	10.00
" 29	T. W. Macfarlane	5.00
	Total	$3,165.00

THE PRESIDENT: What shall be done with the report of the Secretary as presented?

MR. GARSTANG: I move that it be received and referred to the Auditing Committee.

The motion was carried.

THE PRESIDENT: The report of the Treasurer is in order.

Mr. O. Stewart, the Treasurer, submitted the following report:

TREASURER'S REPORT.

Balance on hand, as per last report		$ 813.34
Amount received from Secretary for dues, after the Convention of June, 1896	$860.00	
Amount received from Secretary, at Convention, June, 1897	175.95	
		1,035.95
Total		$1,849.29
Disbursements.		
Paid, at Convention 1896, bill of A. B. Smith & Co	$ 12.53	
" R. W. Ryan, reporting Convention, 1896	177.75	
		190.28
Balance on hand, June, 1897		$1,659.01

Respectfully submitted. O. STEWART, *Treasurer.*

June 14, 1897.

Mr. Stewart: We have all listened with a great deal of satisfaction to the report of our Secretary, and this comes really in striking contrast with the report that was made to this Association as long ago as ten years, I think, when I was first elected Treasurer. If my memory serves me right, and I think it does, at that time there was turned into my hands the munificent sum of $16.50 from the former Treasurer. Our bills, however, were not paid. Our Secretary's salary, which amounted to $1,000, had not been paid. This was not reported to the convention at that time. We simply reported what had been paid and made no mention of what was not paid. At this time it is my pleasure to report to this convention that after, as our Secretary says, all of our bills have been paid — with the small amount that will be due for the preparing of two reports, there is at the present time a balance of $1,659.01 in the hands of the Treasurer belonging to this Association. [Applause.] And with this report, gentlemen, I wish to offer my resignation as Treasurer of the Association. This is from no lack of interest in the Association. My interest has been from the first with the Association, and it will so continue. But in connection with this Treasurership, there are some items of expense. There is very little labor, but the most is the time that is consumed. I am located in the northern part of Maine. Our committee meetings are always called at Buffalo, which is considered the most central point, and in order to attend those meetings I have to devote five days' time. Now, I never like to undertake to do a thing when I cannot do the whole of it, and do it as it ought to be done. Last year I did not attend the committee meetings at Buffalo from the fact that I had not the time to devote to it. I then decided that there were gentlemen who lived near Buffalo who could attend to that business without interfering with their own business, who perhaps would be as acceptable to fill this office as myself, and for that reason, and that reason only, I resign my position as Treasurer. Now, in filling this position, gentlemen — excuse me for making any recommendation — I do not assume that I have been fully competent in all points, but in filling this position, remember that your Treasurer is the only permanent member of the Executive Committee, and you want a man there who is thoroughly posted in our By-Laws and in our Constitution, and who has a pretty thorough acquaintance with the membership. I thank you, gentleman, for the honor that you have bestowed upon me these ten years past. [Applause.]

The President: Gentlemen, while the Treasurer's expression of his intention naturally followed the reading of his report, the proper time for the Association to act on it will be at the election of officers at our last session, at which time you can decide whether to perpetuate Mr. Stewart in office, or to accept his resignation and place some one there in his stead. What is your pleasure in reference to the report of the Treasurer?

MR. GILLISS: I move that it be referred to the Auditing Committee.

The motion was carried.

THE PRESIDENT: Next in order is the assessment and announcement of annual dues. The Constitution provides that the Executive Committee shall recommend the annual dues. They have canvassed that question and voted to recommend that the annual dues for the coming year be, as heretofore, $5. That should be acted upon by the membership at large. Have you any motion to make in reference to it?

MR. SINCLAIR: I move that the recommendation of the Executive Committee be adopted.

The motion was carried.

THE PRESIDENT: Next in order is the election of an Auditing Committee. The provision of the Constitution bearing upon this matter is as follows — Article IX, Section 1: "At the first session of the annual meeting an Auditing Committee, consisting of three members, not officers of the Association, to be nominated by any member who does not hold office, shall be elected in the same way as officers are voted for. This Auditing Committee shall examine the accounts and vouchers of the Treasurer, and certify whether they have been found correct, or not. After the performance of this duty, they shall be discharged by the acceptance of their report by the Association." The Constitution provides that this committee shall be elected by ballot, but the custom has been established in recent years of authorizing the Secretary to cast the ballot of the Association. It is for you to say how it shall be done in this case. The Constitution also says that this Auditing Committee shall examine the accounts of the Treasurer; but by your action already taken, the report of the Secretary has also been referred to the Auditing Committee. So that this Auditing Committee, when elected, will have the duty of examining the reports and accounts of both the Secretary and the Treasurer.

Nominations are now in order for the members of the Auditing Committee.

MR. SINCLAIR: I nominate Mr. Henderson.

MR. GARSTANG: I nominate Mr. T. A. Lawes.

MR. SWANSTON: I nominate Angus Sinclair.

MR. SPRAGUE: I move that the Secretary cast the ballot of the Association for the three members nominated.

The motion was carried.

THE PRESIDENT: The Secretary announces that the ballot of the Association has been cast for Messrs. G. R. Henderson, T. A. Lawes and Angus Sinclair as your Auditing Committee. The Secretary also announces that all the accounts and papers which this committee will wish to examine, are ready and may be found in the Executive Committee's room at any time. Next in order is "unfinished business." Has the Secretary any matter to present in that connection?

MR. CLOUD: There are three matters of unfinished business here. One is: at the last convention the name of E. F. Moore was proposed as associate member, and Messrs. Mackenzie, Bradley and Haskell were appointed a committee to report upon the fitness of the candidate for associate membership.

THE PRESIDENT: Is that committee, Mr. Mackenzie being chairman, ready to report on the qualifications of the candidate?

MR. MACKENZIE: I would say, Mr. President, that the report is in the hands of the Secretary now.

MR. SINCLAIR: Mr. President, if you will excuse me for a correction. The report is required to be submitted first to the Executive Committee.

MR. GARSTANG: Mr. Chairman, I move that the report of the committee be referred to the Executive Committee for consideration, and to report on it tomorrow. (Seconded.)

THE PRESIDENT: It is moved and seconded that the report of the committee on the qualifications of Mr. Moore for associate membership, be referred back to the Executive Committee to consider and report at a subsequent session. Are there any remarks on the question?

The motion was carried.

MR. CLOUD: Under "unfinished business" a proposed modification or amendment of the Constitution at the last convention was as follows: That Section 1, of Article IV, be modified to read: "The officers of the Association shall be a President, a First Vice-President, a Second Vice-President, a Third Vice-President, a Treasurer and a Secretary, and they, with the exception of the Secretary, shall constitute the Executive Committee." This was announced at the last convention, so that it is ready for action.

THE PRESIDENT: Gentlemen, that does not require any motion on your part. It is presented in accordance with the provision of the Constitution, which provides that amendments must be read and kept before the membership one year before they can be acted upon. The Constitution provides that a vote of two-thirds of all the members present at the session at which the amendment is submitted shall be required to carry it. The question, therefore, is now on the adoption of the amendment to the Constitution, which provides for the creation of the position of Third Vice-President. That also has the effect of reorganizing the make-up of the Executive Committee, which, if this amendment is carried, will consist of the President, three Vice-Presidents and the Treasurer, the Secretary then no longer being a member of the Executive Committee. Are you ready for that question? All those in favor of the adoption of the amendment as read and explained will please say "aye"— opposed, "no."

The amendment was adopted.

THE PRESIDENT: The Secretary has still another amendment to the Constitution which was announced last year, which he will now place before you.

MR. CLOUD: Another amendment to the Constitution was proposed last year by a committee which had been appointed to consider the matter of Association scholarships, and that committee reported as follows: "The committee gives notice that at the next convention a motion to amend the Constitution will be made as follows: to amend Article VII to read in the second paragraph, 'Acceptable candidates for the scholarships shall be, first, sons of members or deceased members of the Association. If there are not a sufficient number of such applicants for the June examination, then applications will be received from other railroad employes, or the sons of other railroad employes, for the Fall examinations. The Secretary shall issue a proper circular in this case as before.' The last paragraph of Article

VII to read: 'The successful candidate shall be required to take the course of mechanical engineering.'" Signed by the committee.

MR. SPRAGUE: I do not understand that resolution. What class of employes does it refer to?

THE PRESIDENT: The explanation made by the Secretary, which I believe is the correct one, is, that in case the privilege of these scholarships, when vacant, is not availed of at the June examination by the sons of members or deceased members of this Association, it then becomes open to the sons of any railway employes, regardless of the question whether the father of the candidate is a member of this Association or not. That, I think, is the purport of the proposed amendment.

MR. MACKENZIE: Who is the mover of the resolution?

THE PRESIDENT: It was a committee appointed to consider this subject, of which Mr. William Forsyth is chairman.

MR. FORSYTH: I think that your explanation is entirely correct, Mr. Chairman.

MR. SPRAGUE: Do you mean to say that any brakeman or fireman could apply here and get his son in in preference to the sons of Master Mechanics belonging to the Association?

MR. FORSYTH: Yes, sir; if the Master Mechanics do not avail themselves of this privilege.

THE PRESIDENT: I think it may be said in that connection that the qualifications of the applicant would have to be reviewed by the Executive Committee. We have that safeguard.

MR. MACKENZIE: If I am in order, I would like to make a motion in this connection — that that portion of the report should be changed to read: "members of the mechanical department of railroads."

The motion was seconded.

THE PRESIDENT: You have heard the motion, which is to the effect that the privilege —

MR. FORNEY: I should like to amend that still further. It seems to me that the word "deceased" should go in there, that is, the sons of deceased employes.

MR. MACKENZIE: That is already in.

MR. FORNEY: Not in regard to employes. It is in regard to

Master Mechanics, but not in regard to employes. An employe of a road might have died and left a son, who might desire to avail himself of this opportunity. I therefore think the word "deceased" should come in there — if Mr. Mackenzie will accept that amendment.

MR. MACKENZIE: I accept the amendment.

MR. SINCLAIR: As the recommendation of the change originally came from me, I might explain why I thought it would be better to bring it about. Since the scholarships were purchased, the number of candidates has always been short and six or seven scholarships — that is, six or seven years — have been lost when we might have had scholars in, if there had been a sufficient number of applicants. The applicants seem to be no greater in number today than they were when we commenced, and I thought it was a great pity that these scholarships, for which this Association paid a great deal of money, should be lost every year, and I thought the easiest solution of the question would be to lay it open to the sons of all railroad employes. I know at the present time there are sons of railroad employes in Stevens Institute who have to pay their way the same as if there were no scholarships of this kind, and I think it would be very desirable that you open the doors, after your own candidates are provided for, to others to come in. That was the idea of the change. I was very familiar with the working of the scholarships and was urging Master Mechanics all over the country to send their sons to try for the scholarships, and it was the difficulty in getting candidates and the loss of the scholarships that induced me to suggest this change, on which a committee was appointed.

MR. MCINTOSH: I am in favor of at first restricting it to employes of the mechanical department. If we failed to find candidates enough from that department, why then I would be in favor later of including all employes.

MR. WAITT: It seems to me that the amendments as they are now proposed, if carried, will again restrict the scholarships entirely to the mechanical department; and it seems to me it was the idea of a number of members of the Association last year that that was not a wise policy. Of course there are two amendments now, and so it would not be in order to make another; but if the amendment could be changed, using the words "preference to be given to sons of employes of the mechanical department," it would still leave the matter open, if there were not applicants from that department, for the sons of other railway employes to come in.

THE PRESIDENT: I would like to explain to Mr. Waitt that there are not two amendments before the house. Mr. Mackenzie moved to amend, and some one else moved to amend his resolution, and he accepted it. That leaves us with only one amendment.

MR. WAITT: That being the case, I would move the amendment. I don't know just how the wording would come in. The Secretary could probably do it, he having the resolution on the table — that preference be given to the sons of employes of the mechanical department of railroads.

MR. SPRAGUE: I second the motion.

MR. GILLIS: I believe that we ought to confine these appointments to members of the mechanical department. As it is now, the Master Mechanics and their sons are not availing themselves of this privilege, but the number of Master Mechanics is comparatively small, compared with the number employed in the mechanical department. Now, it seems to me we let the barrier down entirely, and make the field altogether too wide. I think we had better go at it gradually and try the mechanical department. If the mechanical department does not avail itself of the privilege of the scholarships, let us extend it to other departments.

MR. PECK: I think Mr. Waitt's amendment covers the ground thoroughly.

MR. MACKENZIE: Some one said something about the sons of engineers, firemen and brakemen. Now, the resolution as presented and amended does not bar those people at all. Any son of a brakeman, or coal heaver, or sand drier, or anyone else who is working in the mechanical department, would be eligible to the scholarship, as I understand it.

MR. GEORGE GIBBS: Will not this amendment carry the question over another year again — a change in the resolution?

MR. MORRIS: While this matter is under consideration — I am one of the mechanical men who has no son to compete, and I think it would be well to provide for that part of the Association. [Laughter.] I would like to have the privilege of recommending some young man in my mechanical department, but still I am barred out because I have no son.

THE PRESIDENT: You must remember the stage of this discussion. Mr. Mackenzie made a motion; an amendment was offered, which was accepted. Mr. Waitt offered another amendment. Mr. Waitt, will you please state your amendment?

MR. WAITT: There seemed to be objection raised to allowing the employes of other departments than the mechanical department to share in the privilege of the scholarship; so that allowing such other department men to come in might not exclude sons of employes of the mechanical department, it would seem wise to make it clear in the Constitution that the sons of mechanical department employes should have the preference, if there were applicants from both sides.

MR. MACKENZIE: I accept the amendment.

MR. HENDERSON: I would like to support what Mr. Morris says. It seems to me that as the scholarships are provided by the Association, it is only right that the members of the Association should indorse those who are examined. It seems to me that there ought to be a clause in that resolution requiring that a recommendation of a member of the Association should be necessary.

MR. WEST: It seems to me that the simplest way out of this matter would be to take the amendment. The original recommendation made all railroad employes eligible. Now, Mr. Waitt's amendment simply says that the sons of men in the mechanical department should be given the preference.

MR. SINCLAIR: Mr. President, I rise to a point of order. There is a specific amendment to change the Constitution, which ought to lie over for one year. I submit that you cannot allow amendments to be made to that proposed amendment without their lying over another year.

MR. VAUCLAIN: Will you have the original amendment to the Constitution read again?

THE PRESIDENT: The Secretary will please read it.

The Secretary read the proposed amendment.

THE PRESIDENT: My ruling on the point which has been made, that is, whether this proposition can in any way be modified and still be acted on at this convention, is that it can be so modified and can be acted on, unless some member objects, in which case it will have to go over. I am in doubt whether Mr. Sinclair wished to lodge an objection or whether he simply called attention to the question.

Mr. Sinclair: I merely called attention to the question. I would be perfectly willing to give my consent to anything the meeting proposes to do, but I think that is the proper procedure.

Mr. Swanston: I would move the adoption of the amendment as read. I think that is all that is necessary.

The President: There is a motion before the house, which must be acted on first. Mr. Mackenzie's motion was made and seconded, and that must be acted on.

Mr. Swanston: The idea that I wanted to convey was, that if this is adopted barely as it reads, then there could be instructions to the Executive Committee to make the choice from members of the Association first; from the members of the mechanical department second, and then from the railway employes, if necessary.

The President: That might be an escape from the trouble, but we cannot act on that proposition unless Mr. Mackenzie withdraws his amendment; or you can vote down Mr. Mackenzie's amendment, if you wish.

Mr. Leeds: Mr. President, it seems to me that Mr. Waitt's so-called amendment, which I think is a substitute for Mr. Mackenzie's motion, that we place it first for members of the Association, and following that, preference to be given to members of the mechanical department, covers every ground that could possibly be covered. Mr. Morris' ground is covered there. He has the privilege to recommend anybody in the mechanical department, and after he and others have failed to recommend the employes that he is thoroughly acquainted with in the mechanical department, then comes the chance for other employes to be recommended.

Mr. Mackenzie: Mr. Chairman, will you state the question, please?

The President: As I understand, the amendment which was offered by Mr. Mackenzie, who subsequently accepted some modification of it, was that this proposed amendment of the Constitution shall be slightly modified, simply to read that when it becomes necessary to extend this option to other than the sons of members or deceased members, that preference shall be given to the sons of employes of the mechanical department of railways. Is that correct?

Mr. Mackenzie: Yes, sir.

The President: Are you ready for the question?

MR. LEEDS: Do I understand Mr. Waitt's amendment to be that it should be *sons* of employes of the mechanical department, or employes of the mechanical department?

THE PRESIDENT: The text of the amendment says explicitly that this privilege is to be extended to other railroad employes, or their sons, and this amendment which we are now going to act on simply provides that in exercising that option, preference shall be given to the employes, or sons of employes, in the mechanical department of railroads. Are you ready for that question?

MR. GARSTANG: Are we going to vote on Mr. Mackenzie's motion, or on Mr. Waitt's amendment?

THE PRESIDENT: Mr. Waitt's amendment was accepted by Mr. Mackenzie. You are going to act on Mr. Mackenzie's proposition, which is the only motion before the house at this time.

MR. QUAYLE: I think it was very clearly understood that we were to carry out in the amendment the sense of the original motion, which was not only that this privilege should be extended to sons of employes, but to sons of deceased employes. That does not seem to be embodied in what is presented to us by our President just now.

THE PRESIDENT: I accept that correction, and I will try to state the matter again, which is somewhat involved. The original proposition on which you were asked to vote was, that in case applicants did not come forward at the June examinations, that at the September examinations applications would be received and examinations would be held of those who had applied from the following classes: other employes or their sons. Now, the amendment which you are going to act on provides that in extending that privilege preference shall be given to employes or the sons of employes, or the sons of deceased employes, of the mechanical departments. Is that point correctly stated, Mr. Quayle?

MR. QUAYLE: Yes, sir.

THE PRESIDENT: Are you ready for the question?

MR. SWANSTON: If that is adopted, then does it lie over for another year?

THE PRESIDENT: My ruling was that it would not lie over unless some gentleman made an objection here. If you want it to lie over, you must make an objection to it now. Those in favor of the motion made by Mr. Mackenzie, as just explained and fully elaborated, please say "aye"—contrary, "no."

The motion was carried.

THE PRESIDENT: Now the motion is on the adoption of the original amendment as thus modified, unless some one wishes to object and have it go over another year.

MR. MACKENZIE: I move its adoption.

THE PRESIDENT: It is moved and seconded that the proposed amendment to the Constitution, as modified by the last motion, shall be adopted. Those in favor please say "aye"—contrary, "no."

The amendment was adopted.

MR LEWIS: If I be in order, I would like to ask if the action that we have taken will be acceptable to the Stevens Institute. As I understand it, this scholarship was purchased for the sons of Master Mechanics. Now, will it be acceptable to them to extend that privilege to others?

MR. SINCLAIR: Mr. President, Mr. Barr was one of the committee along with me who purchased the scholarships. I do not know if Mr. Barr is in the room, but if he is, I think he will sustain me in stating that these scholarships were purchased for the American Railway Master Mechanics' Association, with the understanding that the Association should make rules for itself for the giving out of the scholarships. That is, I think, correct.

MR. MACKENZIE: That is correct.

MR. SINCLAIR: Mr. Mackenzie was on the committee, too.

THE PRESIDENT: There is no motion before the house. The Secretary announces that he has no more unfinished business. Has any member anything to come up under that head? If not, the Secretary will make a few announcements.

The Secretary read the following letter:

CHIEF ENGINEER'S OFFICE,
NAVY YARD, NORFOLK, VA., June 5, 1897.

R. H. Soule:

MY DEAR SIR,—I understand through my friend, Chief Engineer Mickley, U. S. Navy, that you will soon be in our neighborhood. I will be glad to see you and your friends at the Navy Yard. It will give me pleasure to show you around.

Yours truly,
JAS. B. SMITH,
Chief Engineer, U. S. Navy.
Head of Department.

Mr. Garstang: I move that the Secretary be instructed to answer the letter. (Seconded.)

The President: It is moved that the communication be received and the Secretary be instructed to answer it, conveying the thanks of the Association. All in favor will please say "aye"—contrary, "no."

The motion was carried.

Mr. Cloud: I am requested to give notice that members of the Master Mechanics' Association desiring return Pullman transportation can obtain the same by applying to Mr. Pflager, who will be at the Hygeia Hotel until Wednesday evening.

Mr. West: I move that a vote of thanks be returned to the Pullman Palace Car Company and Mr. Pflager.

Mr. Henderson: I would like to offer an amendment; that this and other invitations be referred to the Committee on Correspondence and Resolutions.

The amendment was accepted by Mr. West, and the motion was carried.

Mr. Cloud: We have a communication from the Chamber of Commerce of Nashville, Tennessee, in regard to the Tennessee Centennial, with inclosures, which are presented by the Executive Committee. This letter is as follows:

CHAMBER OF COMMERCE,
NASHVILLE, TENN., June 1, 1897.

Secretary American Railway Master Mechanics' Association:

GENTLEMEN,— The Chamber of Commerce of Nashville, Tennessee, together with other official bodies of this city, beg very respectfully to tender herewith a most cordial and pressing invitation for your Association, upon the adjournment of its convention, to visit our Centennial Exposition in a body. Our Exposition opens May 1, and continues for six months.

We can assure you a most hearty and cordial welcome, and will use all possible means to make your stay among us pleasant, and we feel sure that the recollections of your visit to Tennessee will be a matter of pleasure both to yourselves and to the people of our city.

The many attractions and inducements that our State and city have to offer for the meeting here of the different organizations of the country in this our Centennial Year are set forth in part in the accompanying circular. Side trips to any and all points of interest, the many battlefields, Hermitage, Lookout Mountain, celebrated stock farms, etc., can be made in a few hours' ride at greatly reduced rates. Many of the principal points can be reached without charge.

The lowest possible tariff of rates will be established by the railroads. Full information can be had from your railroad agents. This will place it within the province of all to visit our Exposition.

Trusting to have the presence of your Association and its many friends in our city, we remain,
Yours respectfully,
NASHVILLE CHAMBER OF COMMERCE,
By
A. J. HARRIS, *President.*
A. W. WILLS, *Secretary.*

The letter was accompanied with circular letters, unaddressed, from the Governor of Tennessee, the Mayor of Nashville, the Tennessee Centennial Director-General and the daily press of Nashville, offering courtesies and attention.

THE PRESIDENT: The action you have already taken will have the effect of referring that to the Committee on Correspondence and Resolutions. Do you wish to take any other and separate action in reference to it? If not, the Secretary will read the next communication.

The Secretary read a communication from the Chairman of the Entertainment Committee, announcing that on the evening of Wednesday, June 15, would be given the grand ball in honor of the Master Mechanics' Association.

THE PRESIDENT: New business is next in order on our programme of proceedings. Has our Secretary any new business?

MR. CLOUD: I think under this head would properly come this announcement, addressed to the President: "We, the undersigned, propose as an associate member of the Master Mechanics' Association, Mr. Edward C. Bates, of Boston, Massachusetts." Signed by Messrs. Blackall, McConnell and Morris. The Executive Committee considered this, and named as a committee on this candidacy Messrs. Setchel, Stewart and Bartlett, to report next year to the Executive Committee.

At the meeting of the Executive Committee held yesterday, it was decided to recommend to the Association to elect Messrs. G. H. Prescott and W. H. Stearns as honorary members, Mr. Prescott having been a member since 1873 and Mr. Stearns since 1872.

THE PRESIDENT: Do you wish to confirm the action of the Executive Committee by electing Messrs Prescott and Stearns as honorary members?

Mr. Peck: I move that the recommendation of the Executive Committee be adopted.

The President: It is moved and seconded that the recommendation of the Executive Committee, that Messrs. Prescott and Stearns be elected as honorary members, be adopted.

The motion was carried.

Mr. Cloud: I am instructed by the Executive Committee to read the following, addressed to the President and Members of the American Railway Master Mechanics' Association, dated Denver, Colorado, and signed by Mr. Henry Schlacks:

Mr. President and Members of the American Master Mechanics' Association:

Gentlemen,—At the annual convention of this Association held in Saratoga last year the subject of radial stay boilers was considered, and from the discussion on that subject I quote the following extract from the remarks of Mr. Angus Sinclair, on page No. 273 of the printed proceedings of that convention:

"The Denver & Rio Grande was, I think, the first railroad in this country to go to a great extent into the use of radial stays instead of crown bars. They had a very reckless class of men in the early days out in Colorado, men who were not very particular in watching their water, and it was very difficult to keep the water always over the crown sheets. They had probably in one year a hundred crown sheets that were burned, and they never had an explosion from these crown sheets getting exposed to the heat. They invariably relieved themselves without doing very much damage. The men got to have so much confidence in there being no very serious results from a hot crown sheet that there is on record an engineer who said if he was sent out with that engine again he would burn the crown. He was sent out, and he did it; he burned the crown, and they all had perfect confidence that there would be no explosion from that. Of course, the burning of crown sheets is not as common now as it was then. But they have very rarely had serious accidents from that cause, and when they tried using button stays they had some rather serious accidents when the crown sheet got hot."

The remarks contain erroneous statements, convey wrong impressions and are a reflection upon the Denver & Rio Grande Railroad, which I have the honor to represent at this convention, and as they are a part of the proceedings of a convention of mechanical experts as accepted facts, they acquire added weight and importance over an individual expression of opinion, and therefore I am compelled to challenge and contradict the statements made.

Investigation by us, after first having ascertained from Mr. Sinclair that the period when the alleged "one hundred crown sheets were burned" was in the winter of 1881 and 1882, shows that in the entire two years mentioned thirteen crown sheets were damaged from low water in the boilers.

The further statement that "the burning of crown sheets is not so common now as then" is calculated to convey the impression that while one hundred crown sheets are not now annually burned, they run in number pretty close to that figure.

I wish to state that, beginning with 1880, when the mileage of the Denver & Rio Grande Railroad was 360 miles, and the number of engines owned forty-one, rapid and extensive building of new lines was carried on for several years, until in 1883 the mileage of the road had increased to a total of 1,559 miles, including lines in Utah (now under a separate corporation), and a total of 242 engines owned.

The entire system was then of three-feet gauge, with grades ranging as high as four per cent, and even the best of the new men we employed to run the additional locomotives purchased were to an extent inexperienced in the operation of narrow-gauge engines, and had to accustom themselves to the new conditions. It is also true that among the large number of men so employed some undesirable engineers were temporarily employed.

This statement I make to illustrate why in the years 1881 and 1882 we had the misfortune to have thirteen crown sheets burned from low water, but since the years in question I do not think our record in this respect compares unfavorably with that of any other railroad in the country.

The statements made by Mr. Sinclair, which we consider unwarranted, and a reflection upon our company, are not according to the facts as shown by the records of the company, and it is therefore in behalf of the Denver & Rio Grande Railroad Company that this statement is made by me, and I ask that it be filed with the Secretary and made a part of the proceedings of this convention, and be printed in the report thereof.

HENRY SCHLACKS,
Superintendent of Machinery.

DENVER, Colo., May 26, 1897.

Certified correct:

N. W. SAMPLE,
General Superintendent,
In charge of Mechanical Department, Denver & Rio Grande Railroad, as Master Mechanic and Superintendent of Machinery, from 1876 to 1893.

MR. MACKENZIE: In order to bring this matter before the convention, I move that the letter be received by the Association and entered on the minutes.

The motion was seconded.

THE PRESIDENT: You have heard the motion; it is open for discussion.

MR. SINCLAIR: As I am the culprit in this case, I wish to protest as earnestly as I can against the assertion that I was making any implications against the Denver & Rio Grande or its officers. I gave the facts from information that appeared to me to be thoroughly reliable, and in stating that they had a certain number of burned crown sheets, and that no explosions occurred from it, I thought that I was giving the company credit for being among the first to introduce the improvement of stay bolts in preference to crown bars for supporting the crown sheet. It is very well known that accidents are much more common with crown bars when heating occurs than they are with the radial stay bolts, and my intention was to give that company credit for making a great stride in advance. It certainly was a great suprise to me when I heard from Mr. Schlacks that they were aggrieved on account of the statement, for nothing further than doing justice to him and his company ever entered my mind.

MR. HUMPHREY: Now, Mr. Chairman, I think the explanation that has been made by Mr. Sinclair will be perfectly satisfactory to the Denver & Rio Grande people, who, I know, feel very much aggrieved over the statement that was made. But as Mr. Sinclair has so fully explained, we make no further remarks.

THE PRESIDENT: The question then is on the adoption of Mr. Mackenzie's motion, that this communication be received and be embodied in the proceedings.

The motion was carried.

THE PRESIDENT: Has any member on the floor any new business to submit?

MR. MCCONNELL: Mr. Chairman, this is the fourth convention that I have attended, and I have noticed every year we have a great variety of subjects brought up for discussion, and toward the latter end of the meeting there is a hurry to get away, and a number of the subjects do not receive justice. I think the number of subjects provided for the Association is entirely too great, and I desire to make a motion that the Committee on Subjects be instructed to report not to exceed eight subjects for discussion at the next convention of this Association. (Seconded.)

THE PRESIDENT: I will ask Mr. McConnell whether he means to have that motion interpreted to mean that the eight subjects shall include any which may be carried over from the preceding year?

MR. MCCONNELL: That was my intention, that it should mean not more than eight subjects — a total of eight.

THE PRESIDENT: It is moved and seconded that not more than eight subjects, all told, including those which may be carried over from this year, shall be assigned to committees for report to the convention of 1898. Those in favor of that proposition please say "aye"— contrary, "no."

The motion was carried.

MR. LEWIS: Mr. President, I would like to suggest a reconsideration of the action taken on the letter from Mr. Schlacks. It seems to partake too much of a personal character, and that it is unnecessary to burden our records with it, and as Mr. Sinclair seems to have made a satisfactory explanation of the matter, I would move that, in place of its being reported, that the correspondence be expunged from the proceedings. (Seconded.)

MR. WEST: I think that is entirely wrong. Already there have been two or three suits brought against companies and this very quotation has been cited in regard to radial stay bolts against crown bars, and I think it should be embodied in our reports.

MR. HUMPHREY: A motion to reconsider is not debatable, and as I think the less said on that subject the better, I do not know that it is necessary to debate it any further. But the principal object in having this go on the record is, what has just been stated, that all of us probably have boilers with radial stays, and that is an adverse report to those boilers. If the question is debatable, open it up in the proper manner and debate it. If we are not going to reconsider it, I think the less said on the subject the better.

THE PRESIDENT: I think Mr. Lewis' motion, in the particular form in which it is presented, must be declared to be out of order. I think the proper way to bring this matter up would be for some gentleman, who voted in the affirmative, to vote to reconsider this subject, which will bring it before you again.

MR. MACKENZIE: There seems to be no motion before the house, and I do not know that I have any right to say anything, but the proposition I thought Mr. Lewis was going to bring out was that in accepting and printing this correspondence, the explanation given by Mr. Sinclair be attached thereto, so that there will be no conflict between the gentlemen. I think it is due to the Association that it be spread on the minutes, and also that it is due to Mr. Sinclair that the explanation given by him be placed there too.

THE PRESIDENT: I think that requires no action. It goes on the record, as do all the proceedings on debate here. Now, does Mr. Lewis, or any other gentleman, wish to move a reconsideration of this subject? There is no motion. Is there any further new business to be brought forward?

MR. LEWIS: Mr. President, I have been requested to present a resolution. Several prominent members of the Master Mechanics'

Association and the Master Car Builders' Association have expressed the belief that both conventions should be held within one week. In view of this sentiment and in consideration of the treatment which the same question has received by our President in his able address, and in order that the matter may be brought up, I would move:

First, That the Executive Committee be empowered to fix the days of the convention of this Association in 1898, and the hours of the days, regardless of the provisions of the By-Laws;

Second, That the Executive Committee of this Association be also empowered to select six members of the Association to act with it in this matter, so as to make eleven in all; and that it be instructed to request a joint meeting of the eleven with the eleven members of the Executive Committee of the Master Car Builders' Association to consider this question and endeavor to arrange the details, so that both Associations may finish their convention work within one week in 1898; the question as to holding one joint opening session in 1898 also to be left in the hands of this joint committee, to be determined according to its best judgment.

MR. WAITT: I want to heartily support the motion as presented by Mr. Lewis. I think that it is quite generally conceded that the amount of time which has been taken up by the two conventions, or is likely to be before the close of this convention, is really in excess of what ought to be occupied. We are kept away from our stations at home, and there is likely to arise in the minds of some of our general officers the question as to whether it is absolutely necessary to take so much time. I believe that, without slighting the work of either this Association, or the Master Car Builders' Association, that the work could be done within the limits of one week and we will go home less tired and more fully benefited by the work, than we do by stringing it out over the present length of time, and I hope that the motion will prevail.

MR. PECK: I think it is a good idea in one way. We had a few days ago an address from the Governor. Now, if he could have addressed the two conventions in joint session, I think that would be a very good feature.

MR. LEEDS: While I am heartily in accord with this motion, and with all that has been said in speaking of it, at the same time, as one of the Executive Committee of the Master Car Builders' Association, I do not know that it has the authority, now that the Association has closed its labors and gone, to make any such arrangement. At the same time, I would like to see such action taken as will accomplish this end.

MR. SPRAGUE: I would ask for information. Wouldn't it be possible to take a letter ballot and by that means get at the sentiment of the Association and make your arrangements for next year?

MR. SINCLAIR: I wish to draw the attention of Mr. Leeds to the fact that at various times the Executive Committees have taken upon themselves to change the date of the meeting and the Associations always heartily gave in to it, and I do not think, when a very important subject like this is up, that they ought to stand on ceremony or raise small objections.

MR. LEEDS: I will say for the information of this Association, and such of them as did not attend the Master Car Builders' Association, that this view of the matter was very generally discussed and appeared to be very acceptable to a great number of the members of the Master Car Builders' Association. It has been pretty well discussed, in a general way, but nothing was brought before the Association. On the other hand, the date of meetings being simply a matter of the By-Laws, and, not being in the Constitution, I anticipate that it is more than likely — there being eleven in the committee — they will assume the authority to make these arrangements the same as they did in changing dates, which was acceptable. But at the first blush I thought it would be assuming more responsibility than it would want to take. At the same time, if the motion be adopted by this Association, so far as the Master Car Builders' Association is concerned, I believe the Executive Committee will heartily co-operate as far as it can do so.

MR. MCCONNELL: As far as the action of the Executive Committee is concerned in this matter, I am disposed to believe that it is not, as a rule, a very modest body. This convention for a number of years has signified its preference for a place of meeting, and regardless of the preference of the Master Mechanics' and the Master Car Builders' Associations in selecting the place to hold the meeting, the Executive Committees have gotten together and appointed another place. Now, I believe that the Executive Committees are competent to deal with this question, and will do so as they see fit. [Laughter applause.]

MR. HERR: Is there any motion before us?

THE PRESIDENT: There is a motion before us. (Question called for.) Before putting the question, I want to say that the way this strikes me is that by taking this action, you will authorize your Executive Committee practically to modify your own By-Laws, slightly, in their application to next year's convention. There is no reason why the By-Laws of the Master Car Builders' Association should not be adhered to as they stand. They provide that the convention should be held on the second Tuesday in June; that the opening session shall begin at 10 A.M. and the subsequent sessions at 9 A.M., and if this conference committee agrees that the joint convention, if you may so call it, shall meet on the second Tuesday in June, 1898, at 10 A.M., the whole thing is practically accomplished, because when the Car Builders go into session they can modify their own By-Laws, and instead of providing that every subsequent session shall begin at nine o'clock, they can have them begin at any other hour, morning or afternoon, as may be agreed to. I will therefore ask for a vote on ——

MR. GIBBS: Will you read the motion again, please? (The Secretary read the motion.)

MR. GEORGE GIBBS: I simply wanted to find out whether it was definitely stated, so that the convention could act upon it and say that they wanted to have the meetings held in one week. It is such an important reform that I think the committee ought to be recommended or instructed to carry it out, if possible.

THE PRESIDENT: I think that is the spirit of the motion. The question is on the original motion which Mr. Lewis submitted, which has been seconded, and has been read, to the effect that our Executive Committee have power to add six to their number, making eleven in all, and to arrange for a conference with the Executive Committee of the Master Car Builders' Association, which also consists of eleven members, with full power to co-operate with that committee and arrange to carry out the programme of having the conventions of the two Associations in 1898 accomplished within the limit of a single week. Those in favor of that please say "aye"—contrary, "no."

The motion was carried unanimously.

THE PRESIDENT: Is there any further new business to be introduced?

MR. WILLIAM FORSYTH: Mr. President, I should like to bring up the subject of an address in the evening during these conventions, by some prominent railroad officer or engineer. This subject was suggested in an article by Mr. Forney, in the *American Engineer*, in which he said: "It certainly would have the effect of broadening the views of those in charge of the mechanical department if superintendents, general managers or presidents of railroads could be induced to express their ideas of the correlation of such departments to all the others, or if successful manufacturers would give their experience as relates to the construction or management of the rolling stock of railroads. If it were arranged to have an address from some able railroad manager or engineer, or possibly college professor each year, it would seem it might be an interesting and profitable feature of those meetings." I would therefore move that the Executive Committee be instructed to select and invite each year some eminent railroad officer, engineer or college professor to prepare and deliver an address to the members of this Association on the evening of the first or second day of the convention. (Seconded.)

MR. LEWIS: Mr. President, I think it is not sure that the gentlemen have all heard the motion. I would suggest that the Secretary be requested to read the motion.

THE PRESIDENT: The Secretary will please read the motion.

MR. CLOUD: It is moved that the Executive Committee be instructed to select and invite each year some eminent railroad officer, engineer or college professor to prepare and deliver an address to the members of this Association on the evening of the first or second day of the annual convention.

THE PRESIDENT: The motion is seconded and is duly before you. Any remarks on the subject?

MR. FORNEY: As Mr. Forsyth was good enough to quote my name in connection with the motion, I will say very briefly what I had in mind in suggesting it. It was this: Parties engaged in any particular department of human enterprise and following in any particular line are apt to get into grooves and not to see the relation of their own duties to those of other departments. Now, it seems to me it would be a very excellent thing if we could get every year some prominent railroad president, general manager or general superintendent or engineer of a railroad to come before us and give us a carefully prepared address showing the relations which the mechanical department should bear to the other departments of railroads. The same thing is true of men who have any particular scientific knowledge that might be of value. We could get persons to come here who would present some of the questions and discuss them from their point of view. As it is now, we get together and our evenings are generally occupied in some sort of — I hardly dare to say in view of the presence of so many supply men — frivolous enjoyment, but we spend our evenings, I might say, somewhat unprofitably. If we had such a person to come and address us, I think it would be an extremely interesting feature of the meeting. I think it would be a great advantage. I think it would steer the Association in directions in which, perhaps, otherwise, it would not sail. [Applause.]

MR. LEEDS: Inasmuch as one of the advantages to be gained by joint sessions or a joint session at the beginning of the meeting of the two Associations, was that the opening prayer and the subsequent address should be made in the presence of the two Associations, there would be a great deal of time gained, and so I think that the plan proposed could be adopted, and I will move you that this matter be referred to the joint committee of twenty-two of the two Associations for action.

MR. HENDERSON: I second that motion.

MR. FORNEY: I would like to say to Mr. Leeds that it seems to me the object aimed at would be accomplished better if this Association should take action, and then refer the matter of arrangement to the Executive Committee. Take action first on this resolution; this would empower the Executive Committee to select a speaker for the next year, and the arrangements could be made by the joint Executive Committee — refer the matter of arrangement to the Executive Committee.

MR. GARSTANG: I believe there is a motion before us now to adopt this resolution.

THE PRESIDENT: That is so, but I judge this may be considered in the nature of an amendment, but possibly Mr. Leeds is willing to withdraw that.

MR. LEEDS: I am willing to withdraw that.

MR. WAITT: In order to cover the points made, I move, as an amendment to this, that the time feature spoken of in Mr. Forsyth's resolution be eliminated, and instead of saying the first or second evening, say at such time as the Executive Committee is able to arrange. (Seconded.)

THE PRESIDENT: Mr. Leeds has withdrawn his amendment, and we come back to the original motion made by Mr. Forsyth, which was read by the Secretary, but it is now moved that the details of time and place be left with the Executive Committee. Is there any discussion?

The amendment was carried.

THE PRESIDENT: All those in favor of the proposition as amended please say "aye" — contrary, "no."

The motion was carried.

THE PRESIDENT: Has anyone any matter of new business that he wishes to present?

MR. CLOUD: At the Master Car Builders' convention last week a committee was ordered to act jointly with a committee appointed by this Association, if it saw fit to appoint such a committee, to consider whether the standards of the Associations in the matter of square bolt heads and nuts ought in any way to be modified.

THE PRESIDENT: Gentlemen, you are asked by the Master Car Builders' Association to authorize the appointment of a committee to co-operate with one of their committees on this question of reviewing the standards of both Associations in the matter of bolt heads and nuts, the point having been brought out before the Master Car Builders' Association that the manufacturers were not furnishing nuts which conform to the standards of either Association. The question was whether to modify the standards, or to develop a sentiment in favor of requiring manufacturers to adhere to the standards. A very good way probably would be to refer this to the Committee on Subjects.

MR. HENDERSON: I move that the question be referred to the Committee on Subjects, which is to report at this convention.

THE PRESIDENT: It is moved and seconded that this communication from the Master Car Builders be referred to the Committee on Subjects, which is to report at this convention, and to select subjects for consideration at the convention of 1898. Those in favor of the motion will please say "aye" — contrary, "no."

The motion was carried.

THE PRESIDENT: The Secretary has no more new business. Has any other member any? If not, we will proceed to the consideration of the committee reports, according to the programme.

Mr. Sinclair: Mr. President, the discussion of topical subjects comes up at the noon hour; it is five minutes to that now. I suggest — I suppose a motion is not necessary — that we take up the topical subjects.

The President: If no objection is offered, we will proceed at once to the consideration of questions listed under the head of topical discussion. We will proceed to the topical discussion according to programme. Mr. Leeds will be considered as in the chair.

The Chairman (Mr. Leeds): The first subject is "Piston Rods—Best Design and Material"; Mr. G. R. Henderson.

Mr. Henderson: We tested at Roanoke five steel tubes sent us for experimental purposes, preparatory to introducing hollow piston rods, as follows:

INDEX TO SPECIMEN.

Reference Letter.	Outside Diameter.	Inside Diameter.	Length.	Manufacturer.
A	3 inches.	2 inches.	48 inches.	Kellogg Weldless Tube Co.
B	3 "	2¼ "	48 "	Syracuse Iron Co.
C	3¼ "	2¼ "	48 "	Kellogg Weldless Tube Co.
D	3¼ "	2¼ "	48 "	Spang, Chalfant & Co.
E	3¼ "	2¼ "	48 "	National Tube Works.

The reference letters, A, B, C, D and E, will serve to indicate the several samples in the following summary tables of results of tests:

TENSILE TEST OF STRAP TAKEN FROM THE TUBES.

Reference Letter.	Area in Square Inches.	Ultimate Strength in Square Inches.	Per Cent Elongation in 2 Inches.	Per Cent Contraction of Area.
A	0.414	63,280	42.5	55.3
B	0.288	46,940	41.0	64.2
C	0.397	59,540	40.0	51.5
D	0.378	57,430	43.0	53.4
E	0.313	60,256	32.5	37.4

All these samples bent nicely cold and gave a good fracture.

COMPRESSION TEST OF TUBES ACTING AS COLUMNS.

Reference Letter.	Radius of Gyration.	Area.	Total Load.	Pounds Per Square Inch.
A	0.9	3.9	110,000	28,200
B	0.94	3.1	70,000	22,600
C	1.0	4.3	130,000	30,200
D	1.0	4.3	140,000	32,600
E	1.0	4.3	182,000	43,300

The ultimate strength in each case was taken at the point where the column commenced to deflect laterally, and in each case it retained part of this deflection when the load was removed. With this information we think it will be easy to design a hollow piston rod of the requisite strength for any of the regular size pistons for use in locomotives.

An idea occurred to us recently that some connection with the cross-head might be made which would give us immunity from broken rods, and here [producing blue prints] is a suggestion of a radial articulated cross-head. The socket or portion that takes the piston rod is hinged into the cross-head proper. The cross-head pin, of course, passes through the same portion, but this is made so that you could take the slippers, two together, and rock them without moving the piston rod, the idea being that when the cross-head is lined up very snugly to the guides, you have the overhanging tendency of the piston on the end of the rod to make a transverse break. This would prevent anything of that kind, for the reason that the cross-head would swivel in itself.

MR. SINCLAIR: Mr. President, the Schenectady people have had some experience, I believe, with the hollow piston rods. Some of their men are here, and I think it would be good for the meeting to hear what their experience has been.

MR. SAGUE: I would say that we have made designs of hollow piston rods, but we have put none in service, and the information we have on that subject would not be of value.

THE CHAIRMAN: Is there anyone who has had experience with hollow piston rods, either in locomotive or stationary practice, or who knows of their use? If so, we would like to have them favor us.

MR. HENDERSON: I might add that the proportion of weight saved by making them hollow was nearly fifty per cent. Of course, the tube costs much more per pound — probably a little more than twice as much as solid rods, and it is not surprising if the use of those tubes has not been extended simply for that reason ; but we think that by consideration of the saving in weight there probably would not be much difference in the cost of the finished rods. Of course, if you attempt to bore them out it runs up high on account of the labor, but by getting the tube the cost of finishing is about the same as the ordinary rod, except the plugging.

MR. THOMAS R. BROWNE: We have a gentleman with us, Mr. Platt, who has had experience with the use of hollow piston rods, at least in marine work. Possibly he can give us some information.

THE CHAIRMAN: We would be very much pleased to hear from Mr. Platt.

MR. JOHN PLATT: I just thought I would like to state that in England, in connection with torpedo boat practice, that Messrs. Thornycroft have used hollow piston rods for quite a long time. They have given a great deal of study to the subject, and I think I might direct the attention of some of the members of the Association to the fact that by the use of cold-drawn material in the shape of tubes, either in iron or steel, very much better results can be obtained. By taking high carbon steel and cold-drawing it, they get a material which has a harder surface, and they can get a tensile strength up to 100,000 pounds to the square inch and with 80,000 or 90,000 pounds tensile strength they can get 30 to 35 per cent elongation. So they get a material which can be worked to piston-rod use. They have done that in torpedo boat work, and those engines have to run from 420 to 430 revolutions a minute, and their engines are 3,000 horse-power — the two engines deliver 6,000. They have met with eminent success and have done very well with them. I think if those gentlemen who are following out these experiments would look into the cold-drawn iron question — that is, solid-drawn from the billet or the ingot — that they can get some very good results.

MR. FORSYTH: I would ask the gentleman if it is possible to weld successfully the ends of those tubes which are of high carbon and high strength ?

MR. PLATT: I understand they had no difficulty in welding the steel they used. It is not such very high carbon steel. They have experimented and found the right steel for that practice. It has been really a question of experimentation to find out. As a matter of fact you can take that steel and upset it in a hydraulic press and force it into almost any form. You do not have to weld. You can upset in any form you want and produce any shape of the end you want.

Mr. Barnett: I am not frightened at high carbon steel for piston rods, after an experience of some years ago, when a number of odd sized Krupp tires came into my hands. Having no use for them as tires, I cut them up and made piston rods of them. I think all of you know what hard material a Krupp tire is. There has not been a single failure in those rods, and they have the best finish and surface of any rod in our service today.

The Chairman: Did Mr. Barnett say how long those rods have been running?

Mr. Barnett: Three years.

Mr. Herr: I have not seen the drawing that was presented by the first speaker in this topical discussion, but I rather question the advisability of going into articulation in piston rods. A flexible connection with the cross-head has been tried quite frequently, and, as far as I know, never with entire success. The matter of enlarging the end of the piston rod and thereby securing, not only greater strength at the point where breakages usually occur, but also giving the rod, to a certain extent, higher flexibility, has not been mentioned. It seems to me that is a valuable feature of design, in which in general the American railroads are behind the foreign practice. It is quite generally used abroad and is now being used quite extensively here also, in some later designs. I know of engines that have been running for at least two years with that design of cross-head, or that design of piston rod, and while I do not know entirely the results, as far as my information goes they are successful. The substitution of high tensile material has been spoken of, and one speaker says it can be obtained by the cold-drawn process. I would like to inquire whether anyone has any results from the use of nickel steel in piston rods. I believe one of our members has had some nickel-steel piston rods in service for some time. Perhaps he can give us some information.

The Chairman: Please give us the name of the gentleman who has the information.

Mr. Herr: I think our worthy Second Vice-President is the gentleman.

The Chairman: Mr. Quayle.

Mr. Quayle: Mr. Chairman and Gentlemen: I do not think I can add very much to the information already given concerning the nickel-steel piston rod. We have it in service and so far as our observation goes it has given us excellent results. But we have not had it in service long enough yet for me to give a report that would be of any benefit to this Association. But for nearly two and one-half years we have been using the enlarged end piston rod, making it nearly half an inch larger where it comes into the cross-head, and the engines during that time have been averaging at least 7,000 miles a month, and this in continual service for somewhere between two and two and one-half years, and they are about ready for the shop now. We have not had any failure whatever, and we feel that we have been benefited by going in that direction, and I have no doubt that we can, after a while, reduce the diameter of the rod, that is to say between the two connections, and we cut away the shoulder of course. Our object was to reduce the fiber stress at the shoulder by enlarging the rod at that point and reducing the diameter throughout the entire length of the rod, so as to distribute the vibration throughout the entire length of the rod, and I believe that nearly all of the Master Mechanics who have these engines running on their respective divisions have one view — that it is a decided success, because engines running in the same service and of similar design, or nearly so, have a number of broken piston rods that were not of that design but of the old design with a square shoulder.

Professor Hibbard: It is well known a rod may be manufactured with a hole through the body of the rod, though closed at both ends. This can be done by the Mannesmann process, by using a billet tapered at both ends so that the metal will not be acted upon by the rolls. Care would need to be exercised in taking the proper quantity of material to form a piston rod of the desired length. There would then be a hollow piston rod, closed, and hence reinforced at both ends, needing no upsetting, no welding of a piece into the interior and no exterior shoulder with its accompanying difficulties of piston-rod packing. I have not heard of any piston rods made in this way, however.

Mr. A. W. Gibbs: I have seen the enlarged rod used now for about five years, without any practical trouble, and one of the points raised was that in the ordinary design the rod itself is very often stretched because it is so fixed that in keying you can stretch it in the keyway. I have seen them successfully enlarged to a diameter of nearly an inch larger than the rod, but also have seen them tried where the piston rod was at the bottom of the cross-head and worked very successfully. I think there is an idea that there is trouble in getting a metallic packing to go over such a rod. That is not the case. The vibrating cups are laid in such a way that the conical part pulls out and slips over quite a large piston rod end, so that it gives no more trouble than the old style, where we had the fit shouldered down smaller than the rod. The idea was when we went into steel that we wanted to get a soft steel; that wrought iron was good — it was a soft material, and that we could use soft steel that had a higher tensile strength, to advantage. That does not seem to be the case at all. This soft grade of steel seems to be subject to breaking off in detail, on account, probably, of its low limit of elasticity, and I think the tendency is to go to a much higher carbon — for instance, as high as .40 to .45. A gentleman from one of the Bessemer steel works yesterday told me that for such work as bicycle cranks, where they had severe strains, they went as high as .70 per cent carbon, and that this high steel stands punishment very much better than the soft lead-like steel. As for the nickel steel, we have had occasion to make drop tests of a great many axles from soft steels up. Among others that were sent to us were nickel-steel axles for test under the drop. One of the features of ordinary axles broken under the drop is that they bend this way and that way, and when they break they break at once, and there is very little warning. In the nickel steel there were cracks developed sometime before the final fracture. In other words, you have a detail fracture under the drop. When the break occurred it was a long-drawn break, entirely different from the break we get with the ordinary steel. There is one peculiarity about the nickel steel, as I understand it, that it does not weld well, and that the little bubbles or seams in the ingot draw down and appear in the finished steel, not enough to hurt it in the piston rod, but I have noticed in testing it on the testing machine that you cannot with any amount of wear entirely get out those little bits of hair seams. It seems to me that for piston rods it is by all means the finest material that has been presented to us.

THE CHAIRMAN: Will Mr. Gibbs please tell us about what would be the difference in cost, if it were adopted, to the extent that it would be put on the market?

MR. GIBBS: My impression is that one of the steel people stated it was from 3 to 4 cents a pound. I think that in a material where you use a very small quantity, such as piston rods, that the first cost is a matter of insignificance; that the incidental cost due to failures so entirely overshadows the first cost that it is a matter of very little consequence. I have not seen any quotations for forgings — for small forgings like that — but I understand they are prepared to make them. We have had axles presented to us for test, and I think they are looking into the question for some new cars of large capacity.

MR. POMEROY: I know where there are some experiments under way regarding nickel-steel piston rods. Up to the present they found that 3 per cent of nickel would add 1¼ cents a pound to the ordinary steel.

MR. MCINTOSH: I think the point brought out by Mr. Gibbs in regard to the insignificance of the first cost of the steel, compared to the trouble that might result from broken piston rods, is a very good one. We all know that a broken rod is apt to involve damage to the cylinder, and an expense amounting to a great many dollars.

MR. A. W. GIBBS: I beg to call attention to the fact that in adding the nickel the tensile strength of the steel is raised, and, therefore, if you are specifying nickel steel you cannot specify the same amount of carbon that you would in a carbon steel. For instance, those particular specimens had 3 per cent nickel, and they had but .26 of carbon. To obtain a carbon steel which would have the same strength, the carbon should have run between .45 and .50.

THE CHAIRMAN: The next is "Compound *vs.* Simple Locomotives."—W. S. Morris.

MR. MORRIS: I shall not go into details in opening the subject, except to say that in 1893 I was sanguine that the compound engine was a success, and I have no reason to change my opinion, judging from the results that we have obtained. In 1893 the compound engine No. 140, which was on the excursion Saturday, made the record that I gave at that meeting. I have tabulated its performance since that time, now having four years' performance — I think one of the longest comparative statements that has been made between engines of the same class carrying the same steam pressure, and alike in every respect, except that one is a compound and the other ten are simple engines. I shall not burden the Association by reading the four years separately, but will give some of the comparisons for the ten engines for the entire time including the four years. The total mileage in freight service of the ten simple engines was 1,396,663, or an average of about 139,666 as against the mileage of 165,187 for the compound, the percentage being 18.3 per cent more in favor of the compound. The repairs were nearly one per cent more for the compound than they were for the ten simple engines for equal mileage. The oil and waste consumed for the total mileage — which is 18.3 per cent more mileage for the compound — was .2 of one per cent less. The fuel consumed, notwithstanding 18 per cent greater mileage, was 6.9 per cent less. Passing on to the miles run per ton of coal, we find that the compound in the four years made 19.2 per cent more miles to the ton of coal than the average of the ten simples, and ran 30.9 more miles to the pint of oil. The cost per mile run in cents for repairs was .9 of one per cent more, and for oil and waste 8 per cent less; fuel per mile, 21.3 per cent less for the compound, and the total less cost per mile of 8.4 per cent as compared with the ten simple engines for four years.

Now, a little over a year ago we compounded, or rather built, six new engines of our Class G-5, which was a change from the original simple engines. We designed them to carry more steam pressure, and we thought they would be a successful compound, using our standard patterns and designs as far as practicable, excepting that we carried 200 pounds of steam on the compound engines, and 165 on the simple engines. The fuel performance of these six engines for the year ending January 31, 1896, compared with six other G-3 engines for the same period during the previous year was as follows: The engine mileage of the G-3 simple engines was 119,000 as against 120,000 for the G-5 compounds. The tons of coal for the simple engines was 7,667, while for the compound it was 8,456. The freight mileag ewas, for the simples, 1,601,055 miles; for the compound, 2,105,658 miles. The pounds to the car mile for the simples was 9.58, while for the compounds it shows only 8.03. Now, we expected that these engines would haul a greater tonnage because they are heavier and carry more steam, but the fuel economy with them is entirely due to the compound engine, and in pounds of coal consumed per car mile the G-5 showed 16.2 per cent less than the G-3 simple engines. In tons hauled per engine mile, the G-5 show 29.9 per cent more, while in pounds of coal consumed per ton mile the G-5 or the compound show 19.2 per cent less coal burned per ton mile. These

simple engines, that the compound will beat them out on coal consumption every time. In comparing three compound engines with three simple engines of the same class on the same division and in the same service, we find that we have a saving in fuel consumption in favor of the compound between 15 and 17 per cent. These figures were taken from our regular monthly performance sheet, no special test or effort being made to compile them, and I believe they are pretty nearly correct. In connection with that, I wish to say that the three compound engines have a capacity of about 10 per cent more hauling power than the simple engines. I think that has a tendency to favor the compound engine. Otherwise they are just the same and carry same steam pressure. I do not think there is any question but that there is a saving in fuel consumption. So far as the oil and repairs are concerned, if anything, I believe the compound is a little more expensive, but how much I cannot say.

MR. GEORGE GIBBS: As a member of the Association's old Committee on Compound Locomotives, I submit herewith some further figures from service tests on our road with four cylinder compounds.

CHICAGO, MILWAUKEE & ST. PAUL RAILWAY.

Statement showing saving in consumption of coal by compound engines as compared with simple engines for twelve months, ending January 27, 1897.—La Crosse Division.

Months.	Pounds of Coal per 100 Tons Hauled One Mile.		Per Cent Saved by Compound over Simple.
	Compound.	Simple.	
February..	14.10	16.58	17.5
March	13.04	16.13	23.7
April	12.03	15.07	25.3
May	11.34	13.14	15.9
June	10.48	12.72	21.4
July	10.60	12.83	21.0
August	10.97	13.19	20.2
September	11.45	13.75	20.1
October	10.39	12.43	19.6
November........	13.05	15.76	20.7
December	13.48	16.34	21.2
January	14.36	16.89	17.6
Average	12.11	14.57	20.3

During the last two years, I, as an individual, have not attempted to exercise any personal supervision over the tests of compound locomotives. In fact, I have desired to let the engines tell their own story. I have had a record made up from one complete year's performance of eleven Vauclain compound engines, and eleven simple engines of the same build and exactly similar, except that the compounds carry 200 pounds pressure as against 180 for the simple. But I will say that one of the simple engines does carry 200 pounds, and for the three years we have had her in service, we have not been able to discover any economy from the extra 20 pounds pressure. This record is made up on a ton-mile basis. That is to say, we figure up the tonnage for every train, for every engine on the two divisions of the road, and at each end of the division the engines are equally distributed between compound and simple. There are five of each, about. The records for each month are given in detail here — the compound and the simple — in pounds of coal per hundred tons hauled one mile. The record for the compound engine is on an average 12.11 pounds; for the simple, 14.57, or an average economy of the compound over the simple engine of 20.3 per cent. The variations in economy of the compound over the simple run from 25 per cent down to 17.5 per cent as the lowest. There is another conclusion to be drawn from this table which is very easy; that is that at the beginning of the record, the engines were new and the record extends to the 1st of February, this year. The economy in the first month was identically the same as it was the last, which is a pretty good showing for the piston valve. The variations seem to be throughout the year, from month to month, and the economy is no less now than it was in the beginning. In the haste of coming away, I did not get our detail tables, which would show the records of each individual engine, and I do not like to speak definitely from memory; but my impression is that it is very seldom that we find a simple engine with better economy than any of the compounds; in other words, all the compounds stand above any one of the simple engines invariably. One of these compounds we have had in service for about five years. As to the matter of repairs, oil, and so on, I have not the figures with me. In fact, all the engines have not been through the shops, so we could not get much data of value. As to the question which Mr. Garstang raises about the extra hauling capacity of the compounds being a factor in its favor, this is not so in the case of these engines, unless they are thrown into simple gear at starting. They are not as powerful a machine to start as simple engines. But after you get to a speed of seven or eight miles an hour they are much smarter, and at high speeds for express service they are a much smarter engine and do their work much better than simple engines. The starting gear can be thrown in at six miles per hour and under, but the engineers themselves have found out that above that speed it is a detriment rather than an advantage; so that there is no tendency to throw it in except in getting over bad points.

MR. GARSTANG: Mr. Chairman, for the benefit of Mr. Gibbs, I would like to state that the dimensions of the cylinders of the compound are ten per cent larger than the simple engines of the same class, and for that reason they have a hauling power of ten per cent more than the simple.

MR. HERR: I would like to ask each of the last two speakers to state in what kind of service, and, if possible, about the average speed made by the trains which these compounds haul. I think that is a matter that should go on record.

MR. GIBBS: I can undertake to get that later, and the Secretary can incorporate it in the record. I do not like to say positively what the average speed is; but we have frequently made 230 odd miles inside of five hours. The engines are in express-freight service—express and local both. It is in general freight service on a division which has grades up to one per cent as a maximum, and the engine divisions are about one hundred miles long each; but we frequently run the same engine through over both divisions. They are ten-wheel engines with 63-inch diameter drivers. I want to say further that we have had two of the same type of engine in passenger service. I have never been much of a believer in compounds for passenger service; but a year ago we obtained two heavy express passenger engines, and we have made as high as 10,000 miles a month with each engine for several months running, and the engines have been in service now exactly one year, and they are hauling trains up to 500 tons exclusive of the engine, running eighty-five miles in one hour and forty minutes, and the regular run with one of the engines with a train of thirteen cars is an hour and forty minutes from Chicago to Milwaukee. We have not a particle of trouble with the engine.

[Mr. Gibbs subsequently furnished the following information.—SECRETARY.]

I find that the average miles per month for both simple and compound engines will run very close to 3,000. The weight of trains, including engine, will average 725 tons for both simple and compound, the average being very close for both classes. The maximum weight will run up to 850 tons and the minimum down to 300 tons; in other words, the service includes time freights, stock freights and locals.

The speed is scheduled between terminals at 20 miles per hour for time freights, 26 miles per hour for stock, and 13 miles per hour for locals. I find that by averaging a number of records, the actual speed, excluding stops, will run about as follows: Time freights, 24 miles per hour; stock, 30 miles per hour; local, 22 miles per hour. In looking over the year's record covered by the table I find that in every month every compound engine was above any simple engine except in four instances, when a simple engine was found to rank above the two lowest compounds. We estimate that the saving in fuel shown by the table for the compounds will amount to about $60 per month.

MR. GARSTANG: The compounds in service on the "Big 4" road are in general freight service. We have some preferred runs, and one of these compounds is on one of those preferred runs. The average train from St. Louis to Indianapolis is 700 tons, and the distance is 265 miles. They make it inside of twelve hours. I think the maximum grade is about sixty feet.

MR. ATKINSON: We have had two of the different types of compounds working about three and one-half years, and last year each of them saved over simple engines in the same service, on the same section, nearly $2,000 worth of coal, and I shall be pleased to give any member of the Association who would like the information, any details he may require about it on the loaded car-mile basis. As to speed, we never find the slightest trouble in running fifty miles an hour, and frequently do it. We have no compounds with larger drivers than 5 feet 2 inches. They can make fifty-five to sixty miles an hour without any trouble.

THE CHAIRMAN: Will the gentleman please state what the cost of fuel is?

MR. ATKINSON: The average is about $2.70 a ton.

THE CHAIRMAN: It is desirable that we should know the cost, on the tender, of the fuel. If you could give that it would be quite important, I think.

MR. ATKINSON: I should be most pleased to give any information to any of the members who choose to ask me.

Mr. Quayle: We have some compounds on the North-Western Road. About two years ago or more, I could not have spoken so favorably of them as I can today. With the compound engine, as with everything else that comes in new, we find some weak points, and it is only as the designer or the man who builds the engine finds out where the weak points are that he is able to strengthen them, and thereby get a better result and a reduced cost of maintenance. The engines we have now, both four-cylinder and two-cylinder compounds, have been so strengthened as to reduce very materially the cost of maintenance, and in looking over my accounts a short time ago, I found we are getting a saving, our engines being run in freight service, ranging from about 19 to 13 per cent over the simple engine and the simple engine carrying the same steam pressure. I doubt, however, if that cuts a very material figure after we get above 180 pounds, for the simple engine. I am inclined to the opinion that when we get to 180 pounds for the simple engine, we are producing very large economy. A short time ago I made some tests on a testing plant, to learn whether there was a difference in economy between two two-cylinder compound engines having the same heating surface; in fact they were both of the same type except the cylinder ratios, one having a cylinder ratio of 2.17, and the other 2.49, and in order to determine if there was any difference on account of cylinder ratio I bushed the high-pressure cylinder running from 2.17 up to a ratio of 3, and I found that I increased the economy in the engine from 2.17 up to 2½. The curve showed a decided rise, and after we got to the 2½ ratio it began to drop off almost in the same ratio, so that after we had put this engine into service with the same ratio as the other, which was practically 2½, we got the same result.

Mr. Atkinson: In the compound locomotives in Great Britain they generally recommend a ratio of 2¼ to 1. In so far as my experience goes, I am disposed to think that is more nearly correct than any other ratio.

Mr. Quayle: I believe that the men who have given that did not have any extended experience with the compound. I believed that, too; but after putting it on the testing plant with the constant horse-power developed, constant steam pressure and constant speed, I found that the facts did not bear it out and I was very much surprised myself. I believed that 2¼ was all right, but I changed my views after this test.

Mr. Atkinson: I think Mr. Quayle has put his finger exactly on the point. The conditions are not constant by any means, and I think it is for that reason that it is a little better not to go too far with the low-pressure cylinder.

Mr. A. W. Gibbs: Did Mr. Quayle make those experiments with different pressures? That is to say, he found a ratio of 2½ gave the maximum effect. He did not say whether that was with one pressure or several pressures, and the gist of my question is, does he think that the ratio will remain the same for different pressures, or as he raises the pressure will he change his ratio, and how?

Mr. Quayle: The pressure was the same throughout the tests as nearly as we could get it. I might say for the information of those present that this was not a road-service test, but was on a testing plant where we have an absolutely straight line by the Boies Speed Recorder, so far as the speed is concerned.

Mr. Gibbs: What was the steam pressure?

Mr. Quayle: 180 pounds.

Mr. Atkinson: We have two compounds running in the same service, with the same steam pressure — 180 pounds. One has cylinders 19 by 29, and the other 19 by 30, and it is noticeable that the locomotive with the 30-inch low-pressure cylinder drops water from the cylinder cocks nearly all the time, and the other does not. That appears to me to indicate that there is undue condensation in the low-pressure cylinder.

Mr. Mackenzie: Mr. Gibbs, of the Milwaukee & St. Paul made a statement; I did not quite catch the figures, but I understood him to say that for 100 tons per mile he consumed eleven pounds of coal— or eleven and one-half.

Mr. Gibbs: Yes.

Mr. Mackenzie: It would interest me to know whether that was the net tons hauled by the engine, or whether the weight of the engine is included.

Mr. Gibbs: It is the tons of train hauled.

Mr. Herr: I have been greatly interested in the study of the compound engine, and now have under my charge sixteen compound engines of five different types. I have the Richmond, the Schenectady, the Baldwin, the Brooks and the Pittsburg, and, while I am unable to give accurate figures at this time, I will state that all of these types of compound engine are showing economy over the simple engines of the same class as far as we have simple engines of the same class in regular freight service. In investigating this question of the relative economy of the compound and simple engines, it seems to me very important to know in what kind of service the engines are used. My experience indicates that the more severe the service in which the engine is placed, the more economy will be shown by the compound feature. In other words, that we can expect much more economy in mountain service, or heavy grade work, from our compound engines over the simple engines in the same service than we can on the lower grade divisions. It is also my experience that it is not fair to compare engines of different weights on drivers, and different hauling capacity. In looking up this matter recently on a division having maximum gradients of four-tenths, I found that the simple engines, hauling 30 per cent more train, showed an economy of 15 per cent in coal, figured on the ton-mile of train, over other simple engines working in the same district in the same kind of freight service. Of course, if these heavier engines had been compound engines, one might have attributed the saving of 15 per cent to the compound feature, when the greater hauling capacity of the engine is, to my mind, entirely responsible for it. I think, therefore, we should be careful in comparing the performance of compound and simple engines to know that they are of the same hauling capacity; that they are not run on different schedules. I also find that in comparing engines of the same class run on different schedules, that there is quite a noticeable difference in the coal economy per ton-mile hauled in the engines that have the slower schedule, as, of course, we would expect. I merely call attention to these facts because oftentimes in stating the performance of engines, members neglect to state a great many of the conditions, which are really controlling conditions, and without which no judgment can be made as to the relative economy of the engines. We are getting in freight service on divisions having a maximum gradient of 1 per cent an economy ranging from 15 to 20 per cent for compound engines of the same weight and hauling capacity over simple engines running on the same schedule. In mountain service the economy is increased, but I am unable to state the exact figure. It is, however, fully 30 per cent and in some instances higher. There is another condition which governs the performance of compound and simple locomotives, and that is the character of the division on which the engines are worked, whether it is a continuous gradient, or whether the ground is undulating, so that it becomes no longer a question of the steaming capacity of the engine, but it is simply the tractive power over these summits; while on a continuous-rise division it is largely a question of boiler capacity. Where those conditions prevail, not only the weights of the engines and the time schedules should be carefully examined before comparisons are made, but the relative amount of heating surface in the boilers; in other words, the steaming capacity of the engines is a very important factor for consideration on account of the engine on the long gradient being limited in its hauling capacity by the steam it can generate, the horse-power it can produce, and the other simply by its tractive power. I consider, from my experience that the compound engine has come to stay, and is showing a very substantial economy over the simple engine.

THE CHAIRMAN: Gentlemen, the hour has expired, and unless a desire is expressed to carry the discussion over to tomorrow, I will declare the discussion closed.

MR. SINCLAIR: Mr. President, it always has been embarrassing to carry over discussions from one day to another, and it is about as broad as it is long, so far as the time is concerned, to carry it into the regular business hours, and I move that the discussion be continued until it is finished. (Seconded.).

The motion was carried.

MR. DEEMS: I want to say just a word along the same line that Mr. Herr has mentioned, in regard to exercising a good deal of care in making any comparisons between simple and compound engines. I want to relate a circumstance that came under my observation some time ago. I happened to be situated where I was able to compare a compound with a simple engine of the same class exactly. The engine was in freight service on a division about 120 miles long, and month after month comparison was made, and each time was very much in favor of the compound engine, so much so that there remained no longer any doubt as to the economy of the compound engine, in the matter of fuel consumption alone — that is all I referred to. We made no particular comparisons as to other items at that time. In this particular service, which was where the engine would make from twenty-five to thirty miles per hour with a train of perhaps 800 tons, it so happened that the compound engine was placed on a short run where the gradients were sharp, running up close to one per cent, and the question there was the maximum train over the heaviest grade; and it was soon discovered, or at least we thought we discovered, that the compound engine was not equal to the simple engine in this respect. We made some tests and found this to be true — we found quite an important difference, I should say 15 per cent in the train, or perhaps higher than that in some instances — in the train that the compound engine would take over this one per cent grade of about eight miles long, the difference being in favor of the simple engine. Now, I just merely mention that to emphasize what Mr. Herr has said in regard to the care to be exercised in making any comparisons of the kind. This defect in the compound engine I think has been discovered and can be remedied, and I do not state it as an argument against the compounding principle, but to emphasize the point Mr. Herr has raised as to the care which should be exercised in making any comparisons of this kind.

MR. ATKINSON: I hardly thought it was necessary to draw any comparison between different classes of engines. In every instance I have mentioned they were similar engines in every respect, as to boiler pressure and everything else — coal and other supplies, as nearly as we could make them.

MR. MITCHELL: It may be interesting to the members here to know that a few months ago we ordered two engines remodeled — one simple, the other compound — both alike in every other respect, and both carrying the same steam pressure, 180 pounds. At the end of eight weeks we decided we would have some more remodeled. The compound engine had shown such wonderful economy over the simple engine so far as we could get at it in that short time, that we decided we would have the next four engines remodeled as compounds. Since that time we have had twenty-eight of them remodeled on those lines, so that we have twenty-eight compounds and one simple in that lot.

MR. GILLIS: I was somewhat surprised at Mr. Herr's statement in regard to the greater economy of the compound engine on a hilly division than on a flat division. I am not quite positive, but I think the experience on our road has almost been the reverse of that. I think the Chairman could tell us about that. But my idea is this, that on a flat division you are uphill all the time. It is not first uphill and then down, but it is a continual uphill pull. We know that there the engines are kept to their maximum capacity, and the amount of fuel that will be burned over that division is greater than over a hill division, and the result will be that we will get more fuel economy — probably not a greater percentage of economy, but a greater fuel economy on a flat division than on a hill division.

MR. HERR: If I said a flat division, I should have said a division where the work is very heavy. My idea exactly coincides with Mr. Gillis', that the harder you work the engine the greater the economy the compound will show in the same service.

MR. SINCLAIR: Mr. Mellin is in the room. I believe he could give some information on the subject.

MR. CHAIRMAN: Mr. Mellin, of the Richmond Locomotive Works, is called for.

MR. MELLIN: I think it is better that those who have had practical experience with compounds on the road should speak, and I think Mr. O'Herin may have something to say about his experience with the compound.

MR. O'HERIN: I am not prepared to say much on the compound. We have compound locomotives of two different types in service and are getting good results from both of them. I believe that there is economy in the compound locomotive from our experience with it.

MR. SINCLAIR: It seems to me that a discussion on compound locomotives in this Association, without having Mr. Vauclain express his views, is very much like having the play of Hamlet without the Prince of Denmark. [Applause.]

MR. VAUCLAIN: Mr. Chairman and Gentlemen,— I do not know that I can add very much to the discussion that we have already had in regard to compound locomotives, and their uses, and the abuses they are put to. I wish to state however, that the building industry in that direction has not flagged at all; that the tendency seems to be to order more compound locomotives; that is, the percentage of compound locomotives now ordered is gradually increasing. Last year we built a total of 173 compounds. We have now in service something like 800 of these locomotives. The average railroad manager is commencing to find out two things; in the first place, that a compound locomotive for freight service is not only economical, but that it is capable of hauling heavy loads at a higher rate of speed than a single-expansion locomotive, which is due entirely to the increased capacity of the boiler, owing to the low rate of water consumption per horse-power of work performed. It is evident to everybody that if a boiler is capable of evaporating a certain number of gallons per minute, that the less the water consumption per horse-power the greater the total horse-power developed will be. The next thing that has been found out is that for high-speed passenger service, the compound locomotive has turned out to be all that it was ever claimed to be. In other words, while compound locomotives are successfully performing the most exacting local service with an enormous number of stops at very short distances apart — very economically indeed ; that they are especially adapted to high-speed service where large trains are to be handled. Since the last meeting, it has been my pleasure to ride behind compound locomotives of our own manufacture, hauling passenger trains of enormously large dimensions, ranging above 500 tons, and at a rate of speed that it was thought impossible to maintain for any distance. It is a very easy matter to maintain a high rate of speed with a large passenger train for a few miles going down hill, but to continue that speed for fifty or sixty miles regardless of the undulations of the road-bed, is quite remarkable. The compound express engines, hauling the very fast trains on the Atlantic City Road, have shown an extraordinary amount of endurance. We indicated one of those engines last summer toward the latter part of the season, and we were surprised to find that on uphill work, on grades from 35 to 40 feet per mile, we had no difficulty in maintaining between 1,400 and 1,500 horse-power, at a speed running from fifty-seven to sixty miles per hour, with trains of fourteen passenger cars loaded, weighing something over 500 tons. We have changed a great number of single-expansion engines into compounds, and I suppose that there is no doubt that a few compound locomotives have been changed over into single-expansion engines. I think the latter is a mistake. If a railroad superintendent or master mechanic has difficulty with a compound locomotive that he may have on trial, more trouble than he has with single expansion engines, I am inclined to think that it is not the proper idea to discard the use of that engine, simply because he has had that trouble; but for less money than it requires to make the change back into a single-expansion engine, the compound could be changed into a compound locomotive up to date, with all the little improvements that several years' experience has enabled the builders of compound locomotives to equip their engines with. We recently received an order from the Erie Railroad for fifteen additional locomotives — single-expansion — to be rebuilt and changed into compound locomotives.

MR. ATKINSON : One question arises in my mind at the present time, and that is in regard to speed. Most of the compound passenger locomotives are notable for having large driving wheels, and there is a general impression abroad, I think, that after we get to a certain number of revolutions per minute the simple engine is better and freer than the compound. I would like to know whether Mr. Vauclain has any information on that point. At the present time I am building some compound locomotives, and so far as I know they will make as many revolutions as the simple engine will without increasing the back pressure at all. If there is anyone with any opinion to the contrary, I should be very much obliged if he would state it.

MR. VAUCLAIN : Mr. President, I hope that you will call on some one who has had an opportunity of using compound locomotives with small driving wheels in service. Mr. Mitchell, of the Erie road, has a number of those engines in fast passenger service that we have altered for them, and I feel that he is better qualified to speak on that subject than I am.

MR. MITCHELL : I would say that the engines we are changing had 68-inch driving wheels; they are hauling the trains that before were hauled with 68-inch driving-wheel single engines, and I consider the compound engine is a much faster running engine in every respect than the simple. You can get up the speed quicker, and you can make up lost time quicker and easier and better. In fact, we have not got the maximum speed out of our engines yet.

MR. HERR : I would like to ask Mr. Mitchell whether the cylinder power — meaning by that not the size of the cylinders, but the actual tractive power of those engines with compound cylinders — is the same as that of the simple cylinders heretofore used.

MR. MITCHELL : In answer to Mr. Herr I will state that in putting on a new boiler on those reconstructed engines, we increased the weight; but the weight of the first simple engine that we bought is the same as the weight of the balance of the compounds that we bought in every respect; so that in comparing one engine with another the tractive power, so far as we know, is the same.

MR. GEORGE GIBBS : I have some drawbar pull curves taken on a dynamometer car with a compound engine. The compound that we have is not as powerful as the simple, but at about ten miles per hour the lines cross, and from there on to forty the compound is much higher than the simple, and I know that those engines run as high as fifty miles per hour in stock freight service, and the indication is that they are much smarter at every speed we have tried them than simple engines, at every period but starting.

A MEMBER: What sized wheel?

MR. GIBBS: A 63-inch wheel.

MR. DEEMS: I just want to say that the case Mr. Gibbs cited coincides exactly with the experience I related a few minutes ago. When you get down to low speed on a sharp grade, it is found that the simple engine would take you over that grade 15 to 16 per cent more quickly than the compound engine. If the train was such that the speed would be maintained, there was no difficulty and there was a positive saving in fuel.

MR. ATKINSON: I rode on a compound engine about three weeks ago, going about six miles per hour, and when the engineer turned her into a simple engine it did not make the slightest difference, and when it went back into compound, it did not make any difference either. When we got down to about three miles per hour then the simple engine began to make a little better speed.

MR. GEORGE GIBBS: Mr. Deems' remarks rather throw some doubt on the correctness of the conclusions reached from these tests which I read. I will say of these compound engines that although they are not as powerful as the simple engine in starting, they can be made much more powerful by throwing in the simple gear, and the trains they are hauling are the limited trains on that division. The records are the regular performance sheet records — heavy trains and light trains — you have got the boiled-down conclusion of the entire service on that division. The ultimate economy can be easily determined. The ultimate economy of the compound cannot be known until the record on the performance sheets shows what it is.

MR. LAWLER: From our experience with compounds I cannot call to mind an instance where we have had to double back on hills. While compound engines reduce the speed on a hill, yet their hauling capacity is so much more than that of a simple engine that they will take the train over the grade, but at a lower speed than the simple engine. That is the only point that we see in the compound that is not equal to the simple engine; she reduces her speed on a hill, but we have never yet doubled a hill with a compound. The tonnage is 10 per cent in excess of the simple engine, steam pressure the same, both carrying 170 pounds; but we feel safer in going over a hill with a compound with a bad rail than we do with a simple engine.

PROFESSOR GOSS . It seems to me that when we undertake to discuss the relative hauling power of two engines, that we come pretty close to the question of cylinder proportion, and I am interested to know how it is that we determine when a compound engine is made the equivalent in cylinder power of a simple engine. If that can be put in any concise way I should be very glad to have it done. In explanation of this, I will say that in this report which Mr. Gibbs brings to us it seems to me that the slight change in the dimensions of the cylinders of the compound engine would change the point where the one engine would pull more than the other engine.

MR. VAUCLAIN : Mr. President, in regard to the manner of determining the relative cylinder dimensions of the single and the compound locomotives, we try to proportion the cylinders so that we get equivalent drawbar pull in starting. If we err at all, we err on the side of slightly under-cylindering the compound engine on account of having the advantage of slightly additional pressure in the low-pressure cylinder to assist in making the initial start.

On motion of Mr. George Gibbs, the discussion was closed.

THE PRESIDENT : Unless you direct otherwise, we will now proceed to the consideration of the regular reports as scheduled. We will proceed to the consideration of Committee Report No. 1, on exhaust nozzles and steam passages, continued from last year. The following note is made in that connection: "The discussion of the report for 1896 was made the first order of business for 1897. Members who can do so are requested to co-operate with the committee by experimenting upon its conclusions and reporting to the committee, which will report further to the convention of 1897, as introductory to the discussion." The chairman of the committee is Mr. Quayle. The Secretary states that he has no extra copies of the report, but he has a number of extra copies of the proceedings of 1896, which can be distributed.

MR. QUAYLE : It was decided last year that the reports be read in abstract, and I will simply read the work as outlined by the committee and the conclusions arrived at.

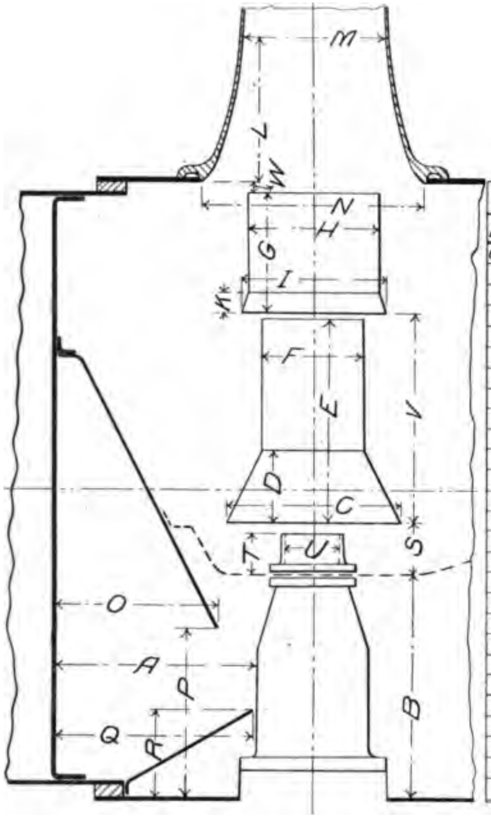
Mr. Quayle then read the conclusions given in the report, and added :

Now, I might say that our chairman very wisely asked me to look up some of the members of the Association who had this front end, as outlined by your committee, in service during the last year, to speak upon this topic. As has been very well said today, we do not care to discuss theories, inasmuch as we have so many practical men here, and the statements of those who have had experience on this line will count for much more than any theory we can put up. There are a number in the Association—I do not know whether they are here now—who have had experience. I would like also to make the suggestion that it is only by the known failures that we can expect to improve on what we have, and it is not wise, nor is it profitable to this Association, simply to take up those who have experimented with this and found it to meet all of their requirements; or, in other words, who have been very well pleased with the results obtained by the application of this nozzle, stack and front end generally to their locomotives; but we would like to hear particularly from those who have found that this has not been as advantageous to them, if at all, as they would like to have had it; and it is only by getting hold of the failures that we can expect to have improvement. Therefore I would very much like, as chairman of the committee, and speaking on behalf of the committee, to have them bring out those points quite freely.

THE PRESIDENT: The names of the parties whom the chairman of the committee thinks are in a position to throw some light on this matter are the following: Mr. McIntosh, of the Chicago & North-Western; Mr. Hennessey, of the Michigan Central; Mr. Herr, of the Chicago & North-Western; Mr. Atkinson, of the Canadian Pacific; Mr. Cockfield, of the Chicago & North-Western; Mr. Peck, of the C. W. I. & B., and Mr. Sague, of the Schenectady Locomotive Works. I will call upon these gentlemen in order. Is Mr. McIntosh, of the Chicago & North-Western, here?

MR. MCINTOSH: I have given this subject but little attention in a theoretical way, aside from reading the report of the committee, but have had considerable experience with this front end in a practical way, having fifty-three locomotives equipped with it on the divisions that I have charge of and have yet to find one that cannot be made to steam with this equipment that can be made to steam at all; we find that there is a wide range of adjustment in the different parts that, with intelligent manipulating, will produce

RECORD OF FRONT-END CHANGES.



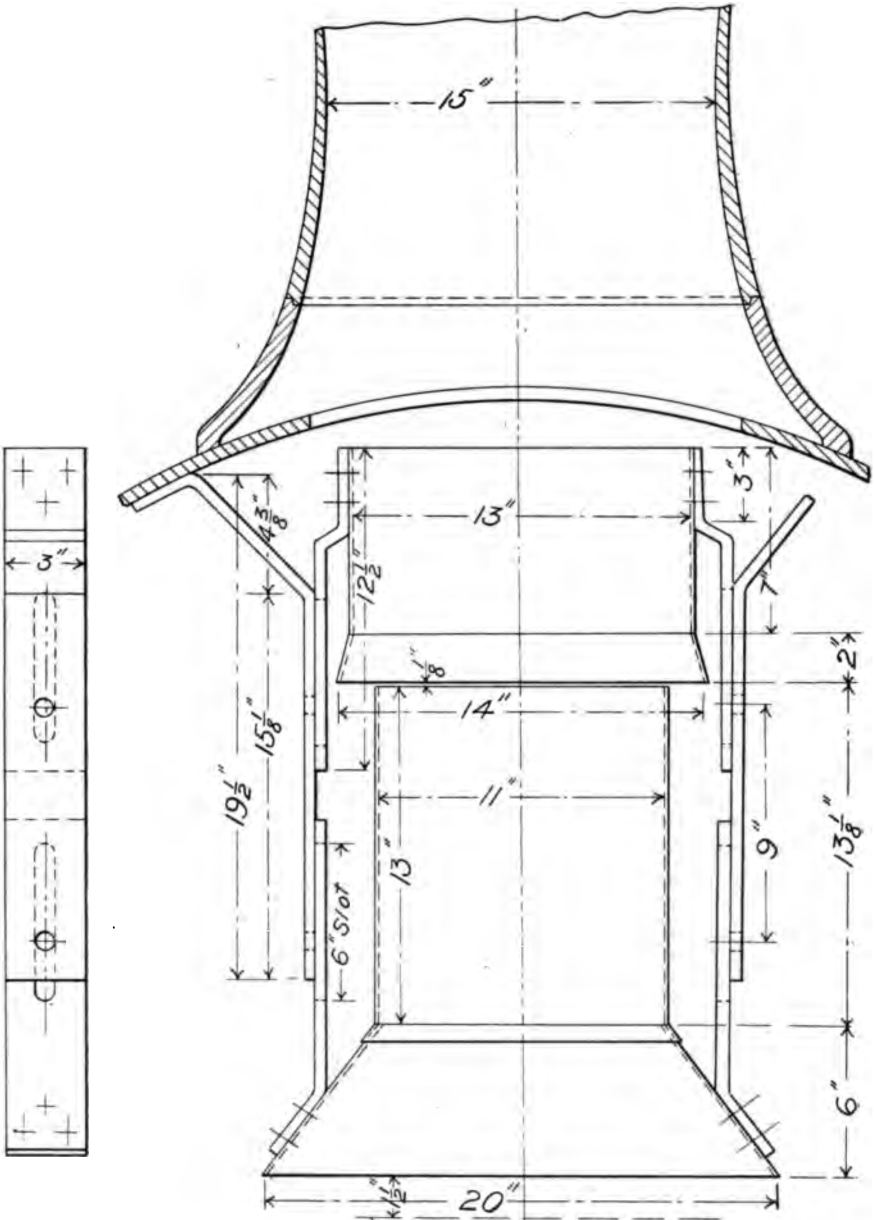
ENGINE NUMBER 797.

DATE	A	B	C	D	E	F	G	H	I	K	L	M	N	O	P	Q	R	S	T	U	V	W	REMARKS.
6-10-97	20	22	17¼	7	20	10	12	13	14	2	12	14	22½	16	16	20	8	5	4	4¼	20½	1½	EXCELLENT.

the combination required; in some cases an alteration of only one inch in height of pipe or diaphragm changing the engine from an indifferent to an excellent steamer. In making investigations in this direction, we found that some sort of a record should be kept of the changes made, otherwise the same ground would be gone over again and again. After trying various forms we finally settled on the one shown in cut, "Record of Front End Changes," with diagram of front end and letters indicating the different positions; the same letters head columns to the right under which are entered in figures the location of the various movable parts with reference to fixed positions. A record of this kind is valuable, as a series of comparisons of charts of a class of engines will plainly indicate the position where best results are obtained; also the positions giving the poorest returns which are to be avoided. I will say in this connection that in my experience in adjusting petticoat pipes, diaphragms and other draft appliances, that we will go along and make changes, and an engine is ordered to another division where the coal is different, or the service is different, and a new series of changes is made, while there is no record of what has already been done in this connection. The result is that work is often done over and over again with no result, while a form of this kind would place it in such shape that it would be always available for comparison.

THE PRESIDENT: The next name on this list is that of Mr. Hennessey, of the Michigan Central.

MR. HENNESSEY: Prior to June, 1896, our 10-wheel passenger engines were equipped with the long exhaust nozzles, heretofore considered the best known practice by our Company, and, as we thought, were giving very good results. The maximum opening at tip was 4½ inches diameter, or area of 15.90 square inches; but this was an exception, in the majority of engines they were 4⅜ inches diameter, or with area of 15.03 square inches. In the latter part of June, 1896, Mr. Robert Miller, Superintendent M. P. and E., took up the matter of the efficiency of our 10-wheel Schenectady passenger engines, and decided to change some of them to conform to the suggestions and recommendations made on the subject at the convention of this Association at Saratoga in 1896, and authorized me to make changes in one or more of these engines, and to carefully note results obtained. Patterns were made conforming as nearly as possible to recommendations of committee on this matter at convention of 1896. After four engines were changed, making the length of nozzle and tip 27 inches,



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M. C. R. R.
PETTICOAT PIPE.

with an area at choke at top of bridge of about 15.78 square inches; different sizes of tips were used, from 4⅝ inches.diameter, with 16 08 inches area, to 4⅞ inches diameter, with 18.66 square inches area. It was found after using this arrangement that enlarging the tip over 20 per cent more than the area at the choke did not show the results that were expected. We then had a nozzle made which gave an area at choke or top of bridge of 20.1 square inches, and used a tip of 4⅞ inches diameter, or area of 18.66 square inches. We used this exhaust with good results. This nozzle was reduced two inches in length, or to 25 inches over all, instead of 27 inches. Several petticoat pipes were used, but pipe as per print M. C. 4 gave best results.

The engines that these nozzles were tried on were 19 by 24 inches cylinder dimensions; 10-wheel Schenectady passenger engines; number of tubes, 247, 2 inches outside diameter, 12 feet 6 inches long; heating surface of tubes, 1,604 square feet; heating surface of fire box, 137.1 square feet; total heating surface, 1,741.6 square feet; grate area of 28.5 square feet.

The comparative results of practical tests made with these engines with front end and nozzle arrangement, before and after alteration, were as follows:

From August 1 to 15, Engine 277, pulling the North Shore Limited between Detroit and Jackson, with front end adjustment previously used, with nozzle 4$\frac{9}{16}$ inches, made 29.35 miles per ton of coal with average train of eight Wagner coaches, weighing 620,450 pounds. The number of coaches hauled one mile per ton of coal was 234.

From August 15 to 30, inclusive, with exhaust and front end arrangement changed as already mentioned, with tip 4⅞ inches diameter, miles made per ton of coal, 38.38; number of Wagner coaches and weight of train same as in former test.

The number of coaches hauled one mile per ton of coal was 307. The time made, weather and general conditions were practically the same in both tests.

A similar test was also made on freight on the Middle Division, M. C. R. R., from Jackson to Michigan City — 153 miles — with Engine 60, a new 10-wheel passenger engine built at Jackson from drawings furnished by the Schenectady Locomotive Works. This test comprised five round trips or 1,530 miles. The first test was made with front end and exhaust arrangement as per original arrangement, with exhaust opening of 4$\frac{9}{16}$ inches diameter. which was the largest nozzle that could be used and obtain steam. The average miles made per ton of coal, 22.61; average tons per train, 893; tons hauled one mile per ton of coal, 20,181.

The front end and exhaust arrangement was then changed to committee recommendation, with opening at tip of 5 inches diameter: Average miles per ton of coal, 26.30; average tons in train, 923; tons per mile per ton of coal, 24,347. This shows a gain of 14 per cent on miles per ton of coal and a gain of 15 per cent on ton-mile haul.

After I furnished Mr. Miller with the data of the tests that I had made, he felt fully warranted in making a further test with our lighter class of standard engines—with cylinders 17 by 24 inches diameter, inside diameter of extension-front end of 52 inches, with length of same 60 inches. Several of these engines have been changed to conform to the committee's recommendations. The results of several tests were equally as satisfactory as in the larger class of engines. We are so well pleased with the general results of experiments made, both as to increased efficiency as well as economy in fuel consumed, that all engines are ordered to be equipped in this manner as fast as they come in shop.

THE PRESIDENT: The hour of 2 o'clock has practically arrived, and under our by-laws a motion to adjourn will be in order, but I will ask your patience for a minute as the Secretary has one announcement to make.

MR. CLOUD:

To the Executive Committee of American Railway Master Mechanics' Association:

We, the undersigned, recommend Mr. G. M. Basford, editor *American Engineer Car Builder and Railroad Journal*, for associate membership in this Association.

W. S. MORRIS.
J. H. MCCONNELL.
JOHN MACKENZIE.

The Executive Committee has named, as a committee to report on this candidacy: A. E. Mitchell, William Forsyth and Angus Sinclair.

THE PRESIDENT: The Chair will also announce that, in accordance with the custom of appointing a Committee on Correspondence and Resolutions, the following committee is now designated: William Garstang, H. Gordon and A. W. Gibbs. Before a motion to adjourn is made, I would remind you that our by-laws provide that our sessions shall open at 9 A.M., and at that time tomorrow morning it will be in order to continue the discussion now in progress, and I will ask that the remaining gentlemen who are listed here to take part in this discussion should take care to be on hand promptly tomorrow morning at 9 o'clock — Messrs. Herr, Peck, Cockfield, Atkinson and Sague.

The Convention then adjourned until the following day.

SECOND DAY'S PROCEEDINGS.

The Convention was called to order on Wednesday, June 16, at 9:15 A.M.

THE PRESIDENT: Before continuing the discussion of reports of Special Committee, the Secretary will read the reports of two other committees, which were appointed yesterday and instructed to report today.

MR. CLOUD: The first is from the Executive Committee, on the candidacy of E. F. Moore as associate member. The Executive Committee have considered the matter, and recommends to the Association that Mr. E. F. Moore, Mechanical Engineer of the Railway Commission of the State of Michigan, be elected as associate member.

THE PRESIDENT: You have heard the report of the Executive Committee on the candidacy of Mr. Moore, Mechanical Engineer of the Railway Commissioners of the State of Michigan, who desires to be an associate member. What action will you take in reference to it?

MR. HENDERSON: I move that the Secretary cast the ballot for his election.

The motion was carried.

MR. CLOUD: The Auditing Committee, which was elected yesterday, has reported as follows:

To the President and Members of the American Railway Master Mechanics' Association:

We have examined the reports and accounts of the Secretary and Treasurer of this Association for the past year, and find the same correct.

G. R. HENDERSON,
T. A. LAWES,
ANGUS SINCLAIR,
Auditing Committee.

MR. PECK: I move that the report be received and the committee discharged.

The motion was carried.

THE PRESIDENT: We are now at the ninth stage of our order of business — the reports of committees — and at the time of adjournment yesterday were engaged in discussing the report of the Committee on Exhaust Nozzles and Steam Passages. That discussion will be continued this morning. It has been suggested that there is a very general desire on the part of our membership to close up our business by 2 o'clock tomorrow afternoon, and if that feeling is general it would be well to be very concise in our work and to expedite it as much as possible.

MR. HENDERSON: I would move that the various papers be read by abstract, the same as was done at the last meeting.

The motion was carried.

THE PRESIDENT: We will now resume the discussion of the report of the Committee on Exhaust Nozzles and Steam Passages, and working from the list which was read yesterday, I will call on Mr. Herr, of the Northern Pacific.

MR. HERR: Mr. President, my experience with the design of exhaust passages and tips and smokestacks recommended by the committee was obtained principally on the North-Western road and in the experiments which were made upon the testing plant. On the Northern Pacific road we are equipping engines with this style of exhaust pipe, nozzle and stack, but have not yet enough in service to speak definitely as to their performance. In order to gain some information that might possibly be of value to the committee and to the Association in regard to this matter, I decided to equip first one of our largest consolidation engines with a 72-inch boiler. The object of this was, if possible, to find out how the committee's recommendation as to the proper distance between the choke of the stack and the height of the nozzle would answer when the boiler shell was very much larger than it was on the engine on which the committee's tests were made, which was, if my memory serves me rightly, sixty inches. In this 72-inch shell, in order in a certain way to continue the experiments of the committee, I had the exhaust pipe made almost as short, if not quite — I think it is quite as short — as the exhaust pipe with which the committee experimented in the tests made on the North-Western testing plant. This will bring the tip of the nozzle eight inches farther from the choke of the stack than the committee's recommendation of about forty-seven inches. My idea in placing it farther from the choke of the stack was to see whether it was not possible, with a larger diameter of front end, to increase the distance beyond what the committee's investigations showed could be done with economy in the smaller front end. I have also had made a tip which extends the height of this nozzle eight inches, so as to bring it exactly as the committee recommends. The engine is now running with the lower tip and we have not yet completed the tests with this tip so as to make the change. So I can give at present no information as to what the effect of the change will be upon that engine. I can simply state that the engine is now running with a 5½-inch single nozzle, while with the old high nozzle, which was in before we made the change — and with a straight stack — the best that could be done to make the engine steam was a 5¼-inch nozzle. The engine is now steaming with a 5½-inch nozzle much better than it did before with a 5¼-inch, and we think we can enlarge the nozzle to 5⅝ inches—possibly more. My experience with the nozzle on the North-Western was decidedly favorable, and I do not know that I can add anything to what the report of the committee contains and the evidence which was given by other members yesterday, to the effect that the design of nozzle is quite an improvement on the old-fashioned high type.

THE PRESIDENT : It is understood that the Canadian Pacific has equipped some engines in accordance with the recommendation of the committee. Will Mr. Atkinson favor us ?

MR. ATKINSON : It is quite true that the Canadian Pacific has commenced to use the arrangement of smokestacks that was recommended at the last annual meeting. We did not commence immediately when I got back home, but I first tried the single petticoat with a shorter pipe than we were previously using — about twenty-eight inches long — and found a decided improvement. We tried a few engines in that way and then commenced to put them in exactly according to the recommendations of the committee, and found a further decided improvement. We have not conducted any tests. We have scarcely thought it necessary thus far. But all engines that go through the shops for general repairs are being altered according to the drawings given by the Association. Our 18-inch 10-wheel locomotives were formerly very seldom, if ever, worked with a larger nozzle than 4½ inches, and not always as large as that. Now we are getting them up as high as 4¾ inches, and I do not think we have yet reached the limit. There is one considerable difference in the arrangement of the smoke box that is foreign to the recommendations — that is, in the position of the baffle plate. According to the recommendations, the baffle plate is behind the steam pipes. We have never been able successfully to operate the locomotives with the baffle plate in that position. We have always been troubled with the front end filling up, and have had to return to placing the baffle plate in front of the steam pipes, and perfectly vertical; so that, as they are working now, we do not get more than half a bucketful of cinders in the front end. We are not particularly troubled with throwing fire — in fact, I think there is less than there was before. We have made a very great gain on coal. The coal that we use is mined in Canada, and speaking generally, appears to be too young, as we frequently dig out pieces of wood from it and it weathers badly — falls down, so that it is not an unusual thing to get from 40 to 50 per cent that will go through a half-inch mesh, and so with a sharp exhaust it simply took a quantity of that small coal and threw it out of the stack. With the softer exhaust of the new arrangement we can burn that coal, and consequently make a very great gain — something that surprised most of us. We do not attempt to attribute it to economy direct, so far as burning the coal better, but we do not throw so much out; and with respect to steaming, where we formerly had a great amount of trouble in the winter and loss of time — that being as much the rule as the exception, almost — now we can get them to steam close up to the full boiler pressure without any trouble. But it is not easy to educate the firemen to the new conditions. Formerly they carried a fire probably seven inches deep. Now they will not work with a heavy fire, and about three inches gives the best result, and they are frequently going to the terminal points showing the grates. They have to fire very light and spread it well, and those who are paying close attention to it do not have the slightest trouble with steaming in any respect.

THE PRESIDENT: Mr. Cockfield, of the Chicago & North-Western, is listed as the next speaker.

MR. COCKFIELD: We have about seventy-five per cent of our locomotives equipped with the front end as reported by the committee. We find our engines are freer steamers, more economical in coal, and we are enabled to increase the diameter of our nozzles from ¼ to ⅜ of an inch. I have taken from my records some figures in regard to the economy we have found since applying this device.

In January, 1895, before this standard front end was adopted, we consumed on the Iowa division of the Chicago & North-Western Railway 7.36 pounds of coal per loaded car mile. As the engines one by one were equipped with this standard front end, we noticed a steady decrease in the coal consumption until January, 1896, when, under like conditions, we were hauling the same cars with 1.22 pounds less coal per car mile than was done in the corresponding month of the previous year, or a reduction of sixteen per cent. This standard was maintained during 1896 with considerably decreased consumption during the summer months, and at the close of the second year we were hauling about the same number of cars with the same amount of coal as we did at the beginning of the year, showing very conclusively the economy and advantage of the front end. As stated, the January, 1897, record was equal to that of January, 1896, and this record was made under the disadvantage of twenty-five per cent of our trains running double-header engines. Taking this disadvantage into consideration, we find a saving of about seventeen per cent in January, 1897, over January, 1895. A comparison made of the pounds of coal per one hundred ton-miles, shows a decrease in April, 1897, from April, 1896, of 1.13 pounds of coal. We do not attribute this wholly to the arrangement of the front end, but it is largely so, as our engines steam very much freer, and naturally, therefore, consume less coal.

THE PRESIDENT: Mr. Peck, of the Chicago & Western Indiana.

MR. PECK: I equipped four engines with front ends as recommended by the committee last year, and I picked out the worst steaming engines and the engines that burned the most coal, and we have got very good results from them so far. We can burn mine-run coal in engines with a larger nozzle and make more steam with them than we did before. We are well satisfied with them and are going to change all our engines as fast as general overhauling becomes necessary.

THE PRESIDENT: The Schenectady Locomotive Works has built a number of engines in accordance with the recommendations of the committee. It is hoped that Mr. Sague, of that company, will favor us with a statement of the results reached.

MR. SAGUE: I will say, Mr. President, that during the last year we have equipped a large number of locomotives — as large a number as we were favored with being able to build — with the committee's standard front end, and in all cases in which we have received definite reports the arrangement has proved perfectly satisfactory. We have in our drawing room several hundred designs of front end, and in building new locomotives, where the design is not definitely specified by the railway company, it is somewhat perplexing for a builder to know just what design is the nearest right. I think this report gives very definite information as to the laws which govern the exhaust jet and the laws which apply to the general arrangement of the draft appliances, and we, therefore, are able to form an intelligent opinion as to which design will work out the best under any definite conditions, and following out the recommendations of the committee's report has resulted in free-steaming locomotives, and we feel that we are on the right track in relation to those appliances. We built five locomotives for the Colorado Midland, of which Mr. A. L. Humphrey is superintendent of motive power. In two of the engines, if I recollect right, we put in the committee's standard arrangement of front end, and in the remaining engines we put in the ordinary high nozzle. Probably Mr. Humphrey would be able to give very definite information as to the comparative merits of those two designs.

MR. HUMPHREY: Mr. President, I have not any data compiled showing the results of our experiments. I can say, however, that we ordered five locomotives, as stated by Mr. Sague. Three of them were according to the design of the Master Mechanics, and two were old style. We experimented with them for about eight months. We found that we could run at least ¼ inch larger nozzle with the Master Mechanics' design than we could with the old. These engines were very large consolidated engines, 21 by 26 inch cylinder. After thoroughly experimenting with them, we changed the other two to conform to the three. They continued to give such good results that we were enabled to increase the size of the nozzles to such an extent that when we ordered five more locomotives of the same type, we made them of the Master Mechanics' design. I am so thoroughly satisfied with the experiments so far, that as fast as we are taking engines through the shop, we are changing all of our engines to conform to this design, and I am satisfied that the results will prove that we can save a very large per cent. If I had known that the question was coming up, I think I could have brought data that would be of interest, but not supposing it would be discussed at this convention, I did not bring it.

THE PRESIDENT: Mr. Rufus Hill, Master Mechanic of the

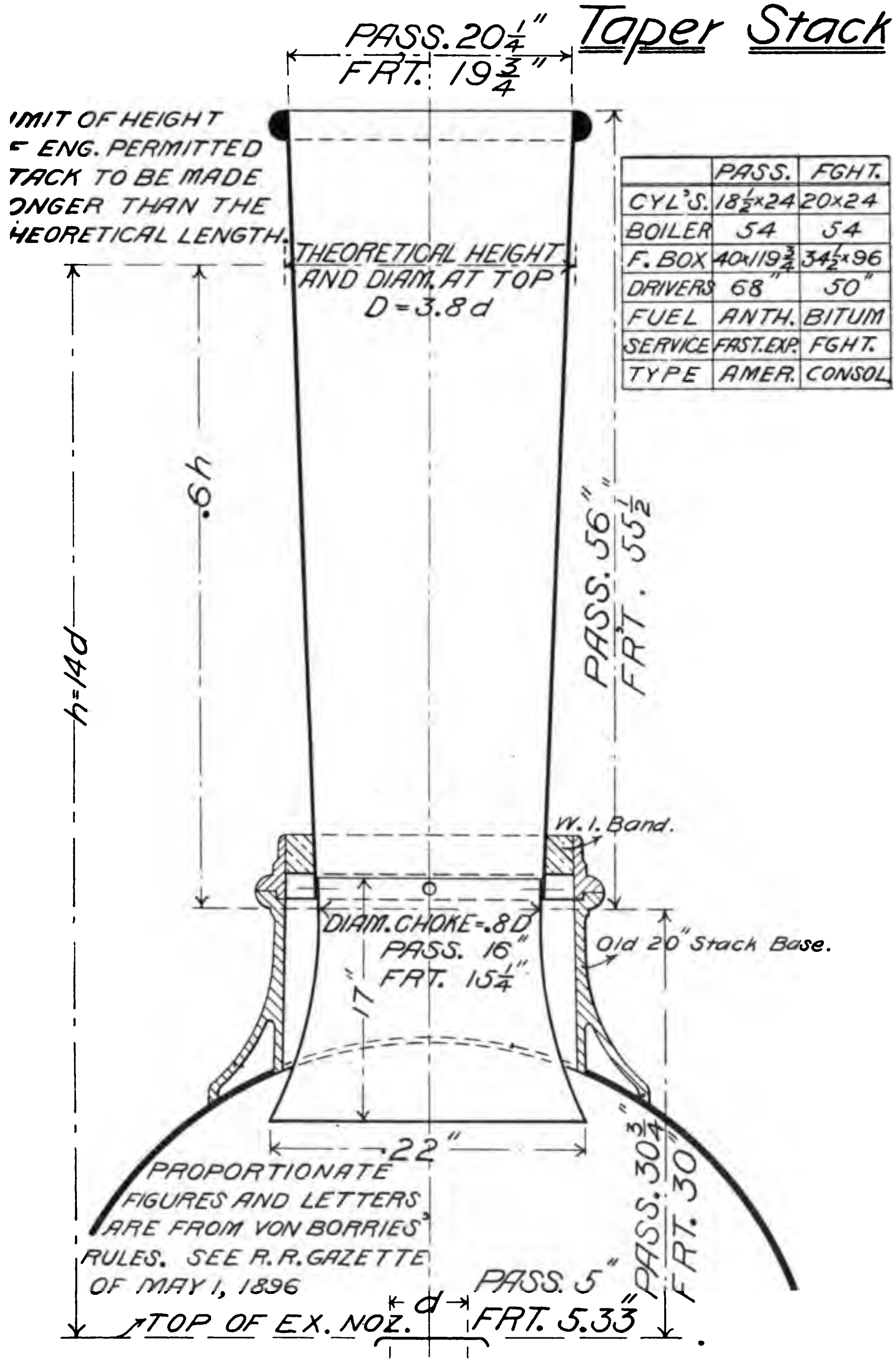
Pennsylvania System, at Camden, N. J., is equipping a number of engines, as recommended by the committee, and having been required to leave yesterday, has left in the hands of Mr. Quayle a memorandum of the results reached, which Mr. Quayle will now submit.

MR. QUAYLE: I do not know that we are justified in saying that he equipped a number of engines, but the fact remains that he has made some experiments with the smoke stack on the lines outlined by Von Borries' experiments on the German railways. He says as follows:

"In May, 1896, one of our express engines was sent to shops to see if any improvement could be made in the draft appliances in order to make the engine steam better. About this time our attention was called to an article on smoke stack and exhaust pipes which appeared in the *Railroad Gazette*, of May 1, 1896. This article gave an account of experiments made by Von Borries, director of Prussian State Railroad; on page 305. He gives the rule for designing a smoke stack and also for ascertaining the diameter of the exhaust nozzle. We followed the rules and equipped the engine with a smoke stack made accordingly. This smoke stack is shown in cut, lettered 'Taper Stack,' as well as the main dimensions for this passenger engine. The cut also shows a smoke stack which was subsequently applied to a freight engine. The results obtained with this stack on the passenger engine were very gratifying, this engine being required to haul a train varying from five to eight cars, eighty-one miles at forty-five miles per hour. The engine burned soft coal and the boiler was rather too small for the work required. In previous years the engineman had hard work to make schedule time and was invariably late; with the experimental stack the engine was able to make time through the heavy summer season. In the fall the engine was shopped for a larger boiler and the stack was dispensed with. While the engine was able to make schedule it was done by an increased coal consumption.

"This increase was, however, slight, and warranted by the benefits derived. You will notice in comparing the dimensions of the stacks there is a very little difference in them, and yet on comparing the dimensions of the two engines as given in the cut, you will see that they vary greatly. It should be said here that the dimensions worked out by Von Borries' rule could not be strictly adhered to in either case on account of mechanical difficulties. The variation, however, was very slight, and on the blue print you will find the proportionate

Taper Stack



	PASS.	FGHT.
CYL'S.	18½×24	20×24
BOILER	54	54
F. BOX	40×119¾	34½×96
DRIVERS	68"	50"
FUEL	ANTH.	BITUM
SERVICE	FAST. EXP.	FGHT.
TYPE	AMER.	CONSOL.

sizes and figures called for by Von Borries' rule. The result with the stack in freight service was also gratifying. The difference between the stack shown here as Von Borries' design and that recommended and shown on Plate 48 in the report of the Committee on Exhaust Pipes and Steam Passages, made at the Master Mechanics' Convention in 1896, is that the exhaust nozzles are somewhat nearer the choke diameter of the stack, and also that the exhaust nozzles, instead of being as low as possible, as recommended by the committee, are located above the center of the smoke box. While the results from this stack have been good, yet we have not been able to get exact figures as to the merits of the design, owing to the fact that the engines have been in service outside of our jurisdiction. In the discussion on the report of the committee at last year's convention, the point was made that but two or three size stacks were necessary for the various classes of engines.

"The results obtained with this stack, which as above mentioned is almost alike in dimensions for both passenger and freight engines, seem to bear out the conclusion, and yet if the dimensions called for by Von Borries' rule had been closely adhered to, no doubt the results would have been still better; therefore we are still of the opinion that the stack should be designed according to some general rule for each class and size of engine, and we firmly believe that in connection with the stack, if some attention was given to the arrangements in the smoke box, fire-brick arch, grates and exhaust nozzles, the saving in the coal consumption would be marked.

"The final tests and arrangements of all these details can only be made when the engine is in service."

THE PRESIDENT: This exhausts the list of speakers submitted by the committee, and if any other members desire to speak on the subject, they should claim the floor at this time.

MR. FORSYTH: Mr. President, as a member of the committee, it is gratifying to know that the introduction of the nozzle and exhaust pipe which we recommended has produced such good results. But in dealing with it, I think that if we have met with any failures, or found anything wrong with it, that that part should also be told. In order to do the greatest amount of good, I will take up briefly that part of the subject. We have applied this pipe to quite a number of engines of different classes, and the first thing we found in doing it was that if we made the size of the choke about the normal size of the nozzle, and then continued to enlarge the nozzle, that made very little difference in the effect upon the fire. In other words, the area of the choke is the virtual exhaust nozzle. It is the virtual area of the nozzle, and I think a great many have probably been deceived in thinking that they are running with quite a large nozzle, when they are running with a small choke, and the effect on the fire is violent and perhaps wasteful when they imagine that they are doing a good thing because they have a large exhaust nozzle and really have a small exhaust blast area. Now, the practical application of this, it seems to me, is that, in making the patterns for exhaust nozzles, the area of the choke should not be made exactly as the committee recommends, namely, equal to the diameter of the exhaust tip in area, but it should be made of an area equal to the largest exhaust tip that you expect to use, or perhaps even larger than that. I think the experiments with such a choke can be varied considerably without affecting the vacuum. Now, if this choke is made equal to the normal size of the nozzle, it is liable to be gummed up gradually by the lubricants and the grease that come through the nozzle, and become smaller, so that while we may think we are running with a 5-inch nozzle, we may have the exhaust area choked down in the choke to a much smaller area, and that is another reason for making the choke larger than 100 per cent of the nozzle. This relation of the choke of the nozzle to the final exit, it seems to me, is the most important part of the proportions which the committee have recommended, and I would urge the members that they be careful that they do not deceive themselves in allowing that choke to become smaller than the area of the final exit, and I would therefore advise that, as I said before, in making their patterns, they make the area of the choke equal to the largest exhaust nozzle they ever expect to use.

MR. MAHER: We made a test according to the report of the committee, on the arrangement of front end, and found that the application of the petticoat pipes proved detrimental, so we took the petticoat pipes out and got better results. We were able then to increase the nozzle tips from ¼ to ⅜ of an inch, and in doing so overcame back pressure. We made a simple test on the back pressure by drilling a hole in the nozzle pipe six inches below the top of the bridge and tapped a ⅜-inch pipe in there, running through the front end, and attached a steam gauge to it. We found with 4⅝-inch tip that the steam gauge would not show any back pressure at all. In order to find out where the engine would show back pressure we kept reducing the tip. At 4½ inches we did not find any back pressure. At 4⅜ inches the steam-gauge hand would flutter a little; at 4¼ inches it showed from 12 to 15 pounds, and with 4⅝ inches tip the engine did not steam very freely, but with a 4½-inch tip it did very well, and we thought as long as there was no back pressure at 4⅜ inches we would adopt the 4⅜ as a standard. With the 4⅜-inch tip the engines are steaming very freely, and they do not show any back pressure. We have increased the miles run with a ton of coal and get much better results in every respect. The coal that we use is the very cheapest Illinois coal. We use a 3/16 by 1½ inch perforated sheet for netting, which is very fine indeed, and we think with the fine netting that we are using and the poor quality of coal, the results that we get from this stack and nozzle are something extraordinary. Previously we had the high nozzle and we could not get anywhere near as good results out of the engines — that is, for doing the work and for fuel consumption — as we get with the nozzle that the committee has reported. We have four engines equipped now. We did not get the performance sheet out in time to give a definite report on the actual performance of the engines, compared with what it was heretofore. Later on, we will be able to make a more definite report. We are satisfied with the results.

Mr. Humphrey: I would like to add just a few remarks to what Mr. Forsyth has said in regard to the proportion of the choke to the outlet or the exit. Referring to the engines which Mr. Sague mentioned that we received from the works, after being in service for some time, I was satisfied that by increasing the nozzle we did not get the effect we should get, so I took the standpipe out and measured the choke. Notwithstanding that we were running with a 5½-inch nozzle, I found that the choke was equal to a 5-inch area, so that we really did not increase the exit any by increasing the size of the tip. I therefore increased the size of the choke to 5¾ inches, allowed the extra area for whatever accumulation there might be on the walls of the exhaust — and I found a very material difference as soon as I increased the choke, just by increasing the tip. We found that the results were very much more favorable than they were with the area of the choke in the standpipe when the engines were received from the works.

Mr. Quereau: I would like to say just a word. We have followed the committee's recommendation as to the front end in fifteen engines on the Burlington & Missouri River. I might duplicate, so far as my observation is concerned, what has been said in favor of the action of this design. I should say, however, that we have omitted the petticoat pipes. With that exception, the front ends are as recommended by the committee.

There is, however, one feature of this discussion which it seems to me ought to be brought out. I have had the statement made to me by four or five gentlemen, who usually know what they are talking about, that notwithstanding the fact that the engines with this arrangement of front ends steam very freely, that the nozzle can be enlarged, yet there is an increased consumption of fuel. That would seem absurd on the face of it. If we could reduce the back pressure, enlarge the tip and make the engines steam more freely than before, there certainly should be a reduction of fuel used. But this statement, coming to me from so many different sources, and from men who usually know what they are talking about, it seems to me it is well to bring this feature up. I agree with what most of the speakers have said, that there would be a fuel saving, and yet I can conceive that we might have a larger tip and a freer steaming engine, and yet consume more fuel, if we assume that the tip has not been enlarged to the extent that is possible, and if we also assume that the choke is of smaller area than the tip that is being used. For instance, I have in mind one exhaust pipe which was designed so that the choke should be 100 per cent of the 5-inch tip. With the old style high-exhaust nozzle, these same engines had been able to run with a 5-inch tip, and therefore when the Master Mechanic used a 5¼ or 5½ inch tip, he did not increase the back pressure, but he did increase the vacuum in the front end. And therefore it is easy to see that, although the tip might be increased and the engine might be made more free in steaming, there would still be a greater coal consumption. I agree with Mr. Forsyth in what he said to the effect that this discussion should not be simply laudatory, but that something should be said on the other side.

MR. HERR: I think that, in justice to the committee, attention ought to be called to the exact wording of their recommendation. It seems to me that it covers the point that Mr. Forsyth has raised, which is undoubtedly a good one. The third recommendation of the committee's report reads as follows: "The area of each of the openings of the pipe at the most contracted part should be not less than the area of the nozzle." It does not say how much more it should be, but it should not be less than that, and I would like to state that in conducting the experiments on the testing plant for the committee, we investigated the relative proportion of area of choke and nozzle and over a range of 60 per cent of the area up to 109, I believe, it was, it was found that a larger opening of choke up to 100 per cent gave an improvement. Above that there was no improvement noticed. But it is very possible that there would be an improvement even above that under certain conditions. I think the object of this choke ought to be mentioned. The only object of choke, as I understand it, is to get the steam directly, more centrally with the stack; in other words, to condense and direct the jet in the best manner. Professor Goss' experiments showed that the more dense the jet was, the higher the efficiency. In order to get the jet dense, it is necessary to centralize it as far as possible, and avoid the cross-fire that you get with the ordinary old style of arrangement. Several gentlemen have spoken of leaving out the petticoat pipes. I think that they ought to state for the benefit of the members what size of front ends these engines had in which the petticoat pipes were left out to advantage.

Mr. Sinclair: Mr. President, I think that there are elements outside of the steam generating appliances that may account for the working of an engine not being so economical with a very large nozzle as it is with a smaller one. A number of years ago a very thorough series of experiments was conducted by a Mr. Martin, who was locomotive superintendent in Peru at the time. He was a member of this Association and reported the results of his experiments in very great detail. He experimented very largely with exhaust nozzles and he found that when he came to a certain degree of opening that the economy of operation decreased instead of increasing. He tried the thing so often that he made certain that there was no mistake about it. He indicated the engines at the same time, and his conclusion was that the vapor went so thoroughly out of the cylinders with the large nozzles that there was not enough confined in it to make sufficient compression at the end of the stroke to fill the clearance spaces before the next stroke began. That was his conclusion.

Another series of experiments with which you gentlemen may be familiar is that made by the Locomotive Superintendent of the London, Chatham & Dover Railway some years ago with a new class of engine which he had got out — a rather famous engine at the time — and a very thorough description of the experiments was published in some of the proceedings — I think the proceedings of the Society of Civil Engineers of Great Britain. He held and maintained that he obtained a horse-power for about two pounds of coal, and he attributed a great part of the economy to the fact that he retained sufficient steam in the cylinders to bring compression up to initial pressure before the stroke began. There appears to be an impression among our people that it is impossible to make a nozzle too large. The practice of making nozzles small has cultivated that idea. But now when the tendency is to make the nozzles as large as possible, it ought not to be forgotten that there is a possibility of carrying that good thing too far.

MR. GILLIS: Mr. Chairman, I think there is a tendency among most of us younger men, when we come to a convention and hear matters of this kind discussed and hear the excellent results accomplished, if we had the power to do it, to go home and say that is just the thing for us. It is like the compound engine. We used to hear of savings of 40 per cent or 50 per cent, which seemed to be enormous, and I do not doubt that the error existed there simply from the lack of getting a proper result in making a few experiments. I believe, before making any sudden changes in a large equipment, we ought to put our present equipment in its best shape and get the best results from that. I know that by carefully watching, and possibly changing, the fireman, a very large increase of fuel economy can be accomplished with exactly the same arrangement of front ends, diaphragms, nozzles, etc., with the exception of slightly changing and increasing the nozzles. When we make these comparisons, I think we ought to know exactly what we are doing. I think all will agree that when we apply a new device we watch it very carefully, and I believe if we watched the old devices as carefully as we watch the new ones, we would get a great deal better results.

Not long ago, in riding on engines, I noticed one fireman fired very heavily. I spoke to him about it. He said: "I have got to do it; this engine is drafted so strong that I have got to fire heavily, or it takes the coal off the grates." Another fireman I noticed was firing very light on exactly the same size engine. He fired light because his nozzle was large, and there was quite a difference in the amount of fuel used. They were alike in every respect. I do not want to throw any cold water on this device in the slightest degree, but before we give it much credit and make any serious changes, I think we ought to look carefully into the appliances we have at the present time, and get the best possible results with them.

MR. FORNEY: Mr. Sinclair has just referred to some experiments made by Mr. Martin in South America a good many years ago, which some of us old fellows remember and the younger men do not. Reports of those experiments were published in one of the back numbers of this Association, and I wish to refer to the fact that Mr. Martin made a good many experiments with reference to the sizes of the grates and the sizes of openings in the grates, and he showed a very considerable difference in the consumption of fuel by simply varying the size of the openings in the grate. I mean that he covered a portion of the grate with dead plates so as to diminish the live part of it. In hearing this discussion it seemed to me very probable that the exhaust arrangement which would answer with a grate of one size might be a very inefficient arrangement with a grate of another size, and that in experimenting with the front end of a locomotive, you ought at the same time to experiment with the back end, and that some relation should exist between the exhaust part of the locomotive and the part at which you admit the air to the fire.

There is another idea which occurred to me in listening to this discussion. We heard a great deal yesterday about the superior economy of the compound engine. Later in the day, and this morning, we have heard a great deal about the superior economy of the exhaust arrangements, and from the remarks made this morning I infer that one of the most important features or parts of the locomotive is what has recently been called the "choke." Now, it will be a very curious question to know in these comparisons which were made of simple and compound engines, as to what the condition of the choke was on the different engines. If what I heard this morning is correct, if you would allow me to have control of the choke of a compound and of a simple engine, I think I could show a superior economy for the simple every time. In fact, you might undertake to paint a smoke stack of a locomotive sky-blue and show a great economy in sky-blue stacks, if you could only have the proper choke. [Laughter.] So it seems to me that in drawing conclusions here we ought to be extremely careful. What I say this morning is not intended as being any reflection on the merits of the compound locomotive, but it is a reflection on drawing conclusions too quickly before we have thoroughly investigated and gotten at the real causes of the economy of locomotives. [Applause.]

MR. QUAYLE: I think, in a sense, Mr. Forney is correct, and in another sense, he is entirely wrong.

MR. FORNEY: He very often is.

Mr. Quayle: I think, too, that the members who have today stated that they had obtained very large economies as the result of putting in this extended front end as recommended by the Master Mechanics' Association Committee may be entirely correct, and if they are correct then Mr. Forney must be wrong in some way. Now, this is the fact: A supply man will go into your office and he will say, "Here is something I want to put on your locomotive, and it will effect a saving of 10, 15, 20 or 50 per cent." The first thing you or I say to him is: "Let us have two, and we will have no expense at all." He will further say to you, "Give me the worst old scrap pile you have got; give me an engine that does not steam at all," and the fact is some of these have been put into just such engines, and it would not be too much to say you save 75 per cent on that class of engine. But what you ought to do with this arrangement is to put it in against your very best practice; put it into the engine that is giving the maximum economy per hundred-ton-mile, and then if you effect a saving you are getting something over and above your very best practice. That is worth working for. We have heard it said on the floor today that one man will work with eight or ten and another with three or four inches of fire. This is true, and it goes without saying that the man who fires his locomotive with a reasonable amount of fire is the man who is getting the best results. Why? Because he is getting the air up through his coal freely. It mingles with the gases that go off with the coal and he gets a better combustion than the man who has a dead, black, heavy fire. There is another point which occurred to me while Mr. Sinclair was speaking about back pressure. I found on some of our 17-inch locomotives — and I want to say that these were designed on the North-Western road; none of the builders outside of the North-Western road are responsible for them — we found that when we got above a 4¼-inch nozzle we did not get any better results so far as back pressure was concerned, and we looked for the reason for it. We found that our ports down underneath were contracted so that it was not really necessary to go above the area of the port, and when an engine of that class came in to get a new set of cylinders we changed the design and then were able to run that same engine with a 4¼-inch nozzle with excellent results. I mention this because of the fact that we may be laying it to the exhaust pipes when the control may be somewhere else. I also think that the statement made by Mr. Forney that we ought to go to the back end of the locomotive and find out what amount of grate area opening is necessary to get the maximum results, is a very excellent one, and I find with this new form of pipe we are able to run with a better economy with the grates that had the smaller opening before the change was made in the front end, for the reason that the firemen are compelled to fire lighter in order to get economy, to get the best results; consequently the air goes up there more freely than it did before. I would very much like if we could get some more testimony that is against the exhaust pipe. Fire your shot right at it, so that we may get some opposition here to provoke a discussion, in order that we may be able to improve on it.

MR. T. A. LAWES: On the Chicago & Eastern Illinois we equipped six engines with the front end recommended by the committee, and I kept those engines in the roundhouse without overhauling them and putting in new flues, and after they were equipped and went into service — and, by the way, I might state that we try to keep an accurate coal record, and we classify our engines in regard to their hauling capacity and their merits in a numerical order — and I found that none of the six engines ever went to the top of the list, when it came down to the economical consumption of coal — not one of them. I then experimented further. I put a diaphragm in front of the steam pipes instead of back of them, because you can clean a front end by putting a diaphragm in front, while you cannot when back; and I had a hollow cone cast on the exhaust nozzle so that the bottom of the netting would come about to the center of the boiler. I think I had somewhat better results from that practice. But I must say that I failed to find the saving in coal that other parties here have said was accomplished.

MR. J. G. GRAHAM: I have had just a little experience. I equipped one engine — we had nine of the same class and the same size all through and the same sized stack — just changing the draft appliances, nozzles, netting, etc., and that engine has never been able to get up to the same point of economy as the other engines of the same class. Now, I have not experimented very far in changing the petticoat pipe or anything of that kind; but so far as my experience has gone with that engine it has not come up to the same point of economy, so far as fuel is concerned, as the other engines. It steams about the same as the others and hauls the train just as well; but so far as fuel economy is concerned, I cannot see any difference—that is, the difference has not been in its favor. That has been my experience with one engine. I do not want to say that the appliance is not right. But quite a number here have given that appliance a good deal of credit, and I just state this for what it is worth.

Mr. Vauclain: I would like to hear from Mr. McConnell of the Union Pacific in regard to the very low exhaust ports and short front ends. I have used quite a number of those lately and find most excellent results from them.

Mr. McConnell: Mr. Chairman, I suppose most members are aware that we do not use anything but the diamond stack on the Union Pacific Railroad. A number of years ago we used the extension front end and the straight stack, and I think it was in service something like six years; but about five or six years ago we commenced taking them off and equipping the engines with the old diamond stack again. We made a number of experiments and kept shortening down the exhaust nozzles until we found that about 4½ inches high was the right height. We used a petticoat pipe for a 19-inch cylinder about 13 inches in diameter. We set it about 2 inches above the nozzles at the bottom and about 5 inches from the opening of the stack on the side. We use a 28-inch cone. In an 18-inch cylinder these double nozzles are run from 3⅜ up as high as 3¾. It depends on the kind of coal we use. Our coal is all lignite except on the Kansas division where we get Rich Hill coal and that is bituminous. But on the line from Omaha to Ogden and on the branches the coal there is all lignite. It is very light in character and we burn considerable of it, but we get considerable steam out of our engines. We have been experimenting for some time past to increase the steaming capacity of our engines and increase the train haul, and I can give you the results of one year's operation; that is, last year compared with 1895. We made a great effort in train haul. In 1896 we ran 2,038 less trains than in 1895. We handled 37,000 more cars. We made 9,100,000 more car miles and we burned 19,000 less tons of coal. We have reduced the coal consumption for all service in five years 2.61 pounds of coal per car mile. In freight service, on our grades and on the level, we are burning about six pounds of coal per car mile. In freight service we have increased our train haul thirty-two per cent. We have decreased the coal consumption twenty-four per cent and we are still continuing in that direction. I do not know what we can do next year, but we are going to try and do a little bit better.

Professor Goss: As a member of the committee, I would like to remark that it is not necessary that the arrangement recommended by the committee should show a saving over the best practice in other forms of draft appliances in order that the recommendations of the committee may be justified. We all know that there has been a good deal of uncertainty in the design of draft appliances; that trials have been made, and in order to improve the performance of the engine changes have from time to time taken place in the draft appliances of a good many locomotives, especially where the type of locomotive is new. Now, the great thing which has been accomplished by the committee, as I understand it, is the placing of limits and the deduction of laws by means of which a draft appliance may be designed with a great degree of certainty; and even though this appliance is not better than some others which may be in use, the work of the committee, is, I say, still justified.

MR. MACKENZIE: Mr. Forsyth brought out a very good point in respect to the attention that ought to be paid to the choke on the engine, and I have heard a great deal this morning about the choke, but I have not heard anything about the size of the cylinder — whether the choke should be the same with a 17-inch cylinder as with a 19-inch. Nearly two years ago the Schenectady people built us five engines and they put what was supposed to be the Master Mechanics' standard exhaust pipe in them. The area of the choke I believe was about equal to a 4½-inch tip. The engines did very nicely in steaming and showed good results as to consumption of fuel, and in indicating some of those engines we found that the back pressure was very much reduced as compared with our old system. Perhaps we were like a good many others — we did not have a very good system. On account of a peculiar sound of the exhaust in one of them one day we looked into the front end, and found that the engine was running with a 6-inch nozzle. The tip had blown out and the engine was steaming and doing just as much work as with the 4½-inch tip. That led to the conclusion that we had no control over the exhaust by the tip at all; that the choke that Mr. Forney spoke about had all to do with it. We commenced then to increase the choke until we could control the force of the exhaust by the tip. We found that by using a 4⅝-inch tip in an 18-inch engine we were getting very nice results. I also believe that the choke should be regulated in keeping with the heating surface of the engines; the more heating surface the less choke, or the larger the orifice at that point. I believe that is the rule to follow more than any other.

The President: If nobody asks for recognition immediately we shall pass on to the next subject.

The 1896 Committee on Counterbalancing Locomotives was continued with instructions to designate a number of roads to confirm or disprove its recommendations in the report of 1896, and to report the results to the convention of 1897. A supplementary report has been prepared by the committee and will be distributed. Mr. Herr is chairman of the committee.

Mr. Herr presented the following report:

REPORT OF THE COMMITTEE ON COUNTERBALANCING LOCOMOTIVES.

To the President and Members of the
American Railway Master Mechanics' Association:

In accordance with instructions, your Committee on Counterbalancing designated the following roads to confirm or disprove our recommendations in report submitted at the 1896 meeting:

Pittsburgh, Fort Wayne & Chicago.
New York Central & Hudson River.
Chicago, Milwaukee & St. Paul.
Pittsburgh, Cincinnati, Chicago & St. Louis.
Illinois Central.
Northern Pacific.
New York, New Haven & Hartford.
Maine Central.
Chicago, Burlington & Quincy.
Union Pacific.
Louisville & Nashville.

Of these eleven roads only four have reported, viz:

Pittsburgh, Cincinnati, Chicago & St. Louis.
Northern Pacific.
Chicago, Burlington & Quincy.
Louisville & Nashville.

In every case the report has been favorable, all concurring in the opinion that the engines tested rode at least equally well when balanced by the rule recommended as by the usual rule of balancing two-thirds of the reciprocating weights, regardless of the weight of the engine.

The engines tested were of different types, from 8-wheel, mogul and 10-wheel engines in fast mail and passenger service to heavy consolidation engines in fast freight service. In order, if possible, to be able to present more data than could be obtained from the roads designated, requests for information of the action of engines balanced in accordance with the rule recommended by the committee were sent to forty-five other roads; nineteen replies were received, of which only six have tried the committee's method. In none of these were any bad results reported from the use of the rule recommended, two reporting that a larger proportion of the total weight of the engine than $\frac{1}{400}$ could be taken as the allowable weight of the reciprocating parts on each side which could be left unbalanced.

One member reports $\frac{1}{300}$ as giving good satisfaction in an 8-wheel engine in fast passenger service. Another recommends using the rule recommended by this committee for short engines and increasing the unbalanced weight in proportion to the length of the engine.

From the result of actual tests on a number of different roads with different kinds of locomotives, and the further fact that the rule recommended coincides almost exactly in many well-designed engines with the method of counterbalancing long in common use and has received the indorsement of every road which has tried it, your committee has to report that the results obtained show that the principle upon which the rule is based is correct, and indicate that if the proportion of unbalanced weight allowed is incorrect it is on the safe side or too small, and that in any except very high speed engines a larger proportion of unbalanced reciprocating weight might safely be allowed.

The recommendations of the committee might be criticised because the greater unbalanced reciprocating weight throws greater stresses on the frames and adjacent parts.

The stresses from which the track is relieved by increasing the unbalanced weight of the reciprocating parts are, of course, thrown upon the frames and other parts of the engine itself. It is readily shown, however, that the stresses from the amount of unbalanced weight allowed by the rule recommended at the assumed maximum speed of as many miles per hour as the diameter of the drivers contains inches, will be only one-third or one-fourth, in ordinary types of locomotives, of the stresses thrown upon the frame by the pressure exerted by the steam against the piston.

Furthermore, the greatest stresses from the reciprocating parts come at the part of the stroke when those from the steam are the least, that is, at the end of each stroke when steam is being exhausted. There is, therefore, no reason to apprehend any difficulty on this account.

The practicability of allowing a greater amount of reciprocating weight to remain unbalanced in long than in short engines, as suggested in the discussion of last year's report, has been considered. This is being tried by one road—the Great Northern—which reports, thus far, favorable results, although its experience is as yet limited to a small number of engines in service but a few months. A formula for determining the counterbalancing in terms of the length of the engine as well as the weight, has been worked out by Mr. H. H. Vaughan, Mechanical Engineer of the Great Northern, and was explained in a paper read before the March meeting of the Northwest Railway Club. This formula disregards the longitudinal vibrations set up by the overbalance, and while doubtless correct for the "nosing" tendency, has been tried too short a time, in our judgment, to receive indorsement. The matter should be thoroughly investigated, however, as the results, if practicable, are decidedly advantageous.

The importance of adjusting the amount of counterbalance accurately is not generally appreciated. The effect upon the track and bridges is proportional to the overweight, and in high speed engines this weight should be as small as the rule adopted permits and not carelessly permitted to exceed this amount. If entire accuracy is not possible, the amount allowed by the rule should be reduced rather than exceeded.

This is especially true for the main wheel, as the rule recommended slightly overbalances this wheel on account of the weight of the back end of the main rod being considered as revolving weight, when in reality it is part revolving and part reciprocating. The error does not exceed 10 per cent of the weight of the back end of the main rod, and is often much less.

Your committee, therefore, renews its recommendation contained in last year's report, which has been worded differently to correct an ambiguous sentence in the second part of the rule.

Rules for Counterbalancing Locomotive Driving Wheels.

First.—Divide the total weight of the engine by 400; subtract the quotient from the weight of the reciprocating parts on one side, including the front end of the main rod.

Second.—Distribute the remainder equally among all driving wheels on one side, adding to it the weight of the revolving parts for each wheel on that side. The sum for each wheel, if placed at a distance from the driving wheel center equal to the length of the crank, or a proportionally less weight if at a greater distance, will be the counterbalance required.

E. M. HERR,
S. P. BUSH,
W. H. LEWIS,
C. H. QUEREAU,
Committee.

THE PRESIDENT: What action do you wish to take in respect to the supplementary report of this committee?

On motion of Mr. Sprague, the report was received.

THE PRESIDENT: The report is before you for discussion.

MR. HENDERSON: I have been very much interested in reading this report, and am very glad that the recommendations made last year are still in force. I think it is a subject that interests all of us, and I am very glad to have some reliable data to work on. There is one point, however, in the recommendations which I would like to hear discussed, and that is the second clause, which says: "Distribute the remainder equally among all driving wheels on one side, adding to it the weight of the revolving parts for each wheel on that side." Now, we all know that in consolidation locomotives having a small wheel it is almost impossible to get the proper amount of balance in the main wheel. In fact you are generally lucky if you balance the revolving parts. So in that case it seems to me that it is best—and I have generally done this in my practice—to distribute the balance for the reciprocating weight among the other wheels. In other words, as long as you get the proper proportion of reciprocating weights balanced among the wheels on that side, I do not think it makes a great deal of difference whether it be equally divided among all the wheels. Then we may have another case; we may have an excessive weight on one of the wheels, which, of course, is not a good design. In that case we might like to put more on some of the other wheels. So I would like to hear some discussion on that point as to whether there is any reason why the proportion of the reciprocating weights should be equally divided among all of the wheels.

MR. LEEDS: I should say that I would take decided exception, and have always taken exception, to a manufacturer distributing this weight in the manner described by Mr. Henderson, from the fact that I have had very sad experience from the same line of counterbalancing. Some eight or nine years ago we found a great many bent rails — badly bent rails — and they were not only bent vertically but sidewise, and at points alternating just exactly half of the circumference of the wheel. Those engines were perfectly balanced so far as the total weights in the wheels were concerned. They were 45-inch centers with 3-inch tire, and I found that by following up the speed indicators that they never bent a rail at less than about fifty-three or fifty-five miles an hour. When they got up to sixty-five they bent pretty badly, and I followed the matter up until I came to the conclusion that it was a very dangerous practice to distribute any more counterbalance in the front or back wheels of a consolidation engine than was absolutely necessary; that you got a ringing, vibratory motion with the engine; you might say it was almost a circular motion; it was continuously vibrating from side to side and at the same time lurching, and the rails were bent in as well as out from that same motion. We at once counterbalanced those engines properly, as nearly as we could. The main driving wheels we had to leave from 100 to 150 pounds light, although we drilled them out until they were shells and filled them with lead and made new wheels wherever it would pay to do it, and we never have had a bent rail since we distributed the counterbalance where it belonged. And I will say that no manufacturer can send an engine to me unless one of the lot has her wheels taken out and weighed up before they go into service.

Our road was one of the roads chosen for the experiments, and I found that I was rather in an embarrassing position to undertake to make any report or any comparison, from the very fact that until we get to about 130,000 pounds in weight our engines all run so that the variation was only from one to three pounds from what it would be by the rule given by the committee. We have five engines weighing about 145,000 pounds, and they came very close to the same rule, but we changed the reciprocating parts until by the rule we got 21 pounds to each driver, or 63 pounds to the side of the engine less than the counterbalance by the old rule. We counterbalanced those engines which were riding perfectly, counterbalanced perfectly with the heavy reciprocating parts and by the old rule. We counterbalanced them by the committee's rule and with the reduced reciprocating parts, and the engineers all reported that the engines rode a great deal better when shut off and rolling, but they could not see that there was a great deal of difference when they were using steam. I do not think that it is practicable to reduce the counterbalance in an engine weighing less than 130,000 pounds to anything less than the recommendation of the committee. As far as the length of the wheel base is concerned, there undoubtedly is something in that, but is there enough so that we should establish a rule that might possibly be confusing? Most of our railroads have a wheel base running from 24 feet to 24 feet 9 inches, and I do not think there is a great deal of difference in the effect on such a wheel base as that. I think there are a great many who will advocate taking this into consideration who will place the flanged tires forward on a 10-wheel engine and put in a swing-motion truck, which in every case will cause an engine to nose.

MR. HENDERSON: I hope that I have not been misunderstood to mean that I would put in sufficient counterbalance to damage the rail. In the report given last year by the same committee I believe the load which the rail was supposed to carry was referred to — the understanding that the sum of the static weight plus the centrifugal stress of the overbalance should not exceed the safe limit on the rails. If you keep under that limit, it seems to me you certainly want to get the balance some place in the wheels. If you cannot get the proper amount in the main wheel I cannot see that there is any great objection to distributing it among the other wheels, provided you do not overload the rail too heavily. Mr. Leeds said that these engines which damaged the rail were counterbalanced wrong, and he counterbalanced them right. I should like to know just what the right counterbalance was.

MR. LEEDS: I would say that they were counterbalanced right, from the fact that they were counterbalanced by the old rule of two-thirds of the reciprocating parts added to the revolving parts, and instead of being over all the wheels they were distributed wherever they could get them and the most of it was in the front and back wheels. That is the excess. I say we did counterbalance them as nearly correct as we could. We took out the excess in the front and back wheels, and put all that we could into the main wheels and a very little excess in the intermediate; but we did not allow of it in the front wheel, and we were about 150 pounds short on the main wheel after adding what lead we could and all the thickness of the plate. We were about 150 pounds short of counterbalancing the reciprocating parts that belonged on the main wheel. As long as we kept the revolving parts fully counterbalanced we did not consider that we were doing the engine or the track any damage.

MR. SWANSTON: I would like to say that I conducted some experiments with a couple of passenger engines, 18 by 24 with 68-inch wheels. I balanced them as nearly as I possibly could according to the Master Mechanics' formula. I also balanced them exactly as recommended by Mr. Henderson. I ran one of the engines with the same crew, and had one of our best engineers to run, on the same train, for about a month. I also balanced it with a considerable reduction over either of the other weights, and the road foreman, two or three engineers and two or three experts — I did not ride myself — but two or three experts that I sent out there all reported in favor of the lighter weight. Now, the lighter weight was an average on that engine of 285 — division of unbalanced parts, and we think we really got better results. The front wheel would divide by the figure 330 and the back wheel by 240. On another engine having the same sized cylinder but a lighter engine, with a five-foot wheel my experiments ran the same way, and that was an average of 200, but with about fifteen pounds more in the front wheels than there was in the back wheels, and favorably reported on.

MR. FORSYTH: Mr. President, I will only prolong the discussion a minute. In regard to the subject of counterbalance, so far as it relates to the riding of an engine, I think that there is no longer any difficulty; but what we are now interested in is, what is the maximum allowable weight on the rail, and what is the maximum stress on the rail. I have a table here or a series of curves for all our engines showing the maximum allowable speed for any assumed total pressure on the rail, and the total pressure is the static weight on drivers plus that due to centrifugal force, and it shows that even as low as fifty miles an hour with some of our engines we have a total load of 20,000 pounds per wheel and at sixty miles an hour we have 22,000 pounds per wheel. In designing new engines we are continually met with the objection from the Civil Engineer's Department and the roadmasters that we must not exceed certain limits of weight, and it is remarkable how various that is and it is often regardless of the rail section or weight of rail. During the past few years Mr. James Howard, who is at the Watertown Arsenal, made experiments on the Boston & Albany road, on the C. B. & Q. road, and on the Pennsylvania road, to find the deflection in the rails due to heavy driving-wheel weights and the stress in the rails, and he showed that under static loads of 22,000 pounds per wheel that the stress in a 60-pound rail was as high as 19,540 pounds per square inch, while for a 100-pound rail it was only 12,000 pounds per square inch; and again, on another class of engines, having only 15,650 pounds per wheel, the stress in a 60-pound rail was 16,000 pounds, while in a 100-pound rail it was only 8,430 pounds. So that when we come to such fine figures as balancing an engine with one three-hundredth part of its weight deducted from the weight of the reciprocating parts, or one four-hundredth part, it is a question of how much stress can be allowed in the rails on which that engine is to run, and I think we have reached a point in this question where we ought to have the assistance of the Civil Engineers' Society and the rail manufacturers in giving us some information as to what maximum stress can be allowed in different sections of rails.

On motion of Mr. Vauclain the discussion was closed.

THE PRESIDENT: The next report in order will be that of the Committee on Truck Swing Hangers, continued from last year. I understand that Mr. Potter, the first member, and Mr. Lavery, the second member of the committee, are not present, and that the supplementary report will be presented by Mr. Garstang.

Mr. Garstang presented the following report:

REPORT OF COMMITTEE ON TRUCK SWING HANGERS.

To the President and Members of the
American Railway Master Mechanics' Association:

Your committee appointed to advise the proper angle of swing beam hangers in locomotive trucks submitted a report at the meeting of the Association held in Saratoga in June of last year, which report was not completed in time to be printed and distributed to the members before the meeting. The report, however, was read, and without discussion the committee was continued with instructions to make further report.

Quoting from this report: "Now, the function which a swing-motion truck should perform is to be able to move sideways, but in doing so it should exert a pulling action in that direction on the front of the engine, somewhat in excess of the resistance to such movement. It must be admitted by the committee that they have little definite knowledge in relation to the amount of this resistance. It is obvious that in running in a curve a locomotive has a strong tendency to move in a straight line, and that its front end must be pulled toward the center of the curve, but the amount of the lateral motion resistance which must be overcome on curves is unknown. Obviously it consists of two components, the friction of the wheels on the rails and the centrifugal force of the engine. What these actually are for different curves, speeds and engines, so far as the committee is aware, is not known, and they suggest that the determination of the lateral force which must be exerted to guide the front end of a locomotive on curves offers an inviting and probably a profitable field for experimental investigation."

Mr. William Garstang, Superintendent of Motive Power of the C. C. C. & St. L. R'y, made quite elaborate tests with a view to throwing light on this subject. A dynamometer was constructed and attached to the truck axle of a mogul engine, the wheel base and distribution of the weights of which are shown in Fig. 1, and was applied as shown in Fig. 2.

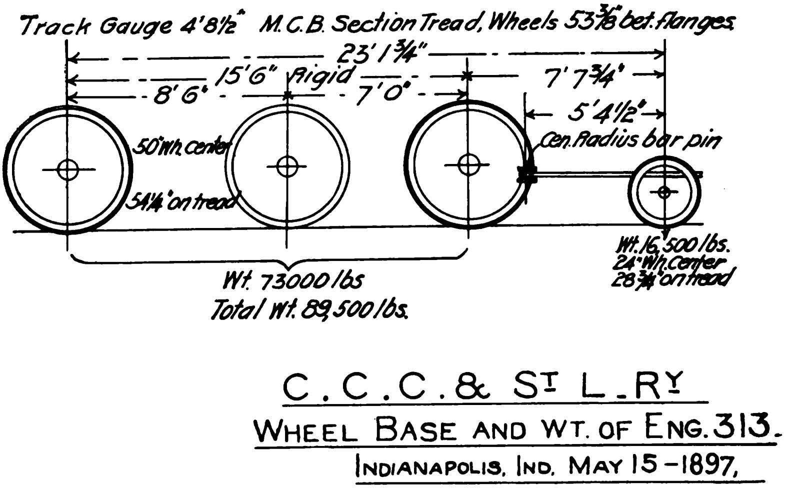
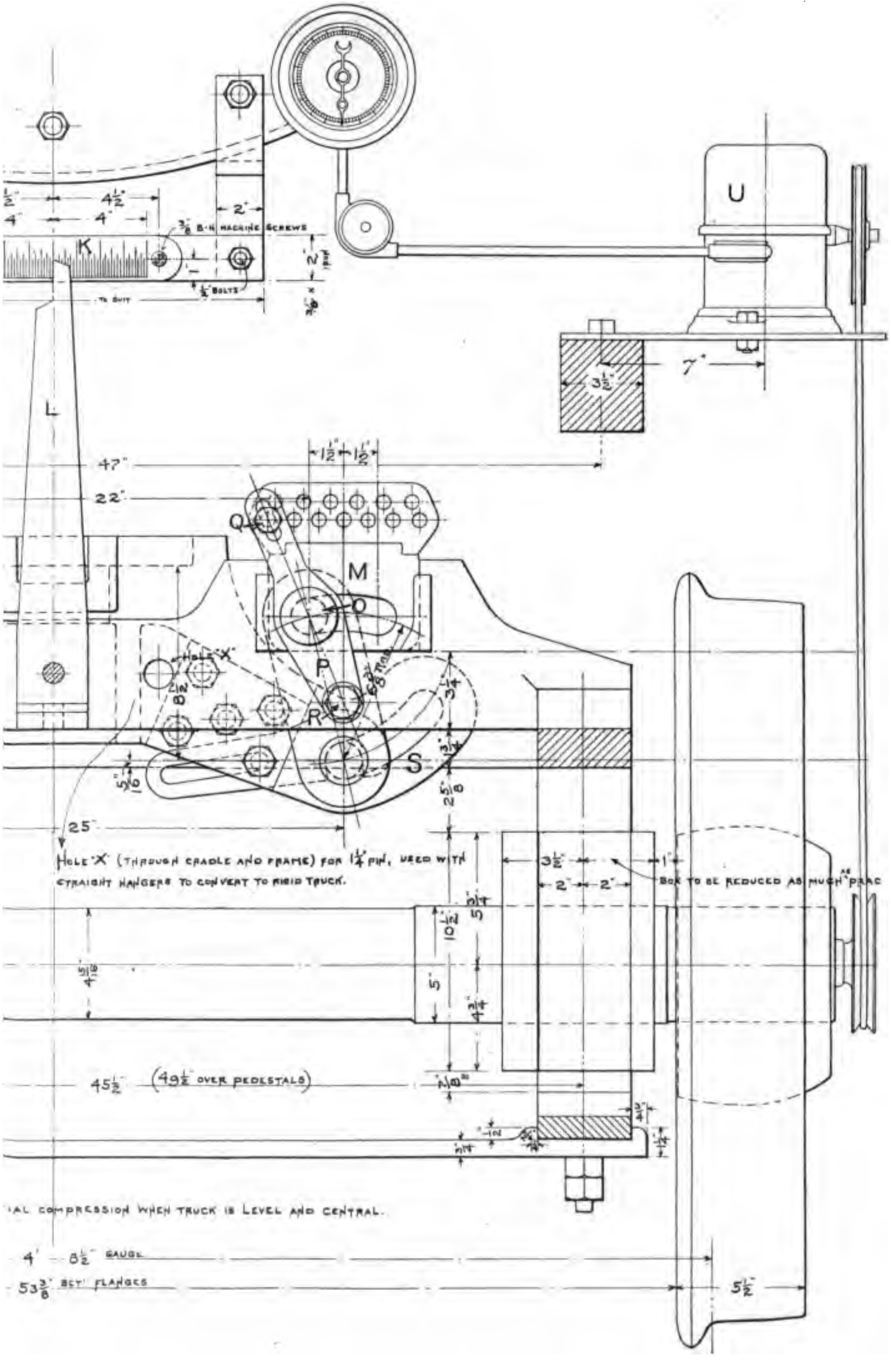


Fig. 1.

A tabulated statement of the results is shown in Fig. 3.

The sections of the tires of the engine truck wheels and of the left forward and left back driving wheels, and the outside rail on the track where the tests were made, are shown in Fig. 4.

U
K
L
M
O
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Q
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S
½"
4½"
4"
4"
2"
⅜" B-H MACHINE SCREWS
½" BOLTS
TO SUIT
2" BAR
⅜" ×
1"
7"
3½"
1½"
1½"
47"
22"
HOLE "X"
6⅞" RAD.
3¼"
3¼"
2⅝"
5/16"
25"
HOLE "X" (THROUGH CRADLE AND FRAME) FOR 1¼" PIN, USED WITH STRAIGHT HANGERS TO CONVERT TO RIGID TRUCK.
3½"
1"
2"
2"
BOX TO BE REDUCED AS MUCH AS PRAC
5¼"
10½"
5"
4¾"
4 5/16"
45½"
(49½" OVER PEDESTALS)
¾"
1¼"
IAL COMPRESSION WHEN TRUCK IS LEVEL AND CENTRAL.
4' — 8½" GAUGE
53⅜" BET. FLANGES
5½"

The operation of the mechanism shown on this drawing is as follows:

Flange *A* is loosely fitted to the axle and is kept in its proper position by a feather on the axle.

B is a flange clamped solidly to the axle with a groove cut in the face to receive the ring *C*. To the upper half of this ring is cast flanges *D*, to which is bolted the vernier *E*. To prevent this ring from turning, an arm *F* is bolted to each side of the box, on which lugs, cast on the ring, rest. The pointer *G* is pivoted on *E* at *H* and receives its motion from the movement of truck frame through the box *I* and rod *J*. This pointer has a ratio of 4 to 1.

The springs are arranged radially around the axle and were carefully tested on a machine, and a table of pressures compiled for each $\frac{1}{64}$ inch compression.

The boiler vernier *K* is attached to the front of the boiler, and the pointer *L* to the cross-bar of the truck, as shown.

The adjustment of the hanger was done by having blocks *M* fitted to the cross-bars, four for the $6\frac{3}{8}$-inch hanger and four for the 8-inch hanger, and slotted radially to suit the length of hanger used. Attached to this block is a plate *N* with a series of holes drilled in same, so arranged that the angle of the hanger was changed two degrees by each adjustment.

The hanger pin *O* passes through the clamp *P*, the clamp *P* being slotted for bolt *Q*, and pivoted at *R*. To change the hanger from position shown to the next hole, the bolt *Q* is removed and the pin *O* moved until bolt *Q* can be inserted in the hole required, this being repeated for each change of hanger.

After running through the series of holes mentioned, it was found that the inside holes were giving the best results. Then it was determined to carry the test further until a change was shown, giving an increase of stress. As the construction of the truck was such as to prevent the carrying of the top pin any closer toward the center, the radial arms *S* were made and bolted to the center casting and tests continued until the result desired was obtained, as shown in the tabulated statement.

The tests were made on the Indianapolis Union Railway Co's tracks, where they enter the Big Four tracks at Brightwood, on a three-degree curve with the outer rail raised four inches, which is suitable for a speed of forty-five miles per hour. The runs were divided into a series of speeds as follows:

For each angle of hanger and also for a rigid truck; that is, two runs at eighteen miles per hour, two runs at thirty-five miles and two runs at forty five miles per hour, or as near as possible to the above schedule. An average was taken of the runs made with each angle of hanger.

The movement of the pointer *G* was recorded on a card by being connected to a Crosby indicator *T*, as shown on blue print, and the speed by a Boyer speed recorder *U*. To insure that all readings were taken at one point, a post was located at the center of the curve, so that it could be readily seen by the operator.

The action of the dynamometer proved contrary to that expected as to its maintaining a constant and uniform pressure after the engine was fully under the influence of the curve. Its apparent action proves that the impact upon entering the curve gave a vibrating action to the springs, and in consequence to the front end of engine, after which the springs seemed at all times to have been compressed and relieved alternately, which it is believed was due to the curve not being a true arc of the circle. The springs, apparently, in addition to this, were compressed to a certain point, and when their combined strength overcame the weight and friction of the wheels on the rails, relieved themselves suddenly and nearly regained their normal set. This gave a line on the card fluctuating from zero to a maximum point, or a resultant stress.

Regarding boiler vernier and needle: As the vernier is attached to the boiler and the needle to the truck frame, both having a movement in the same direction, the total boiler movement includes the sum of the set shown on the dynamometer and the movement of the boiler vernier past the needle. During these tests, and at random apparently, the results show a peculiar circumstance, namely: Indicators will start and show an increase or decrease in relation to angle of hangers, when the engine will assume a position giving readings nearly fifty per cent less than would be looked for, this occurring throughout the test, and is, it is thought, due to certain conditions wherein engine assumed a position on track contrary to its general position, or in other words, hugging the outer rail evenly and smoothly for full length of engine, thereby giving a small truck stress.

The action of the cradle or swing center seemed to be as follows:

Hangers which have an angle inside of an inch either way from the vertical, by reason of the small angle, seemed to allow the boiler to sway to its maximum position and back again to extreme in other direction, this surging tending to raise the stress on truck wheel flange, and speaks for itself in the tabulated results.

Hangers whose angle exceeds this in either direction absorb a part of this sway, and consequently show a reduction of truck stress. The hangers giving the best results, namely, showing the least boiler swing and least stress on the truck wheel flange, were the hangers whose points of suspension are closer together than the suspending points on the center casting. The length of hangers bears an important relation to stress indicated. For instance, the two lengths of hangers used in these tests, one of which was 8 inches and the other 6⅝ inches long, at the 18-degree angle, suspended as before mentioned, showed results which would indicate that the hanger whose arc is of the shortest radius in a given length of movement, and necessarily has the greatest middle ordinate, tends to raise the engine more abruptly and suddenly, thereby absorbing a greater percentage of stress and reducing the flange stress in a corresponding ratio. This shows to be in favor of the short hanger, but just what length would be the mean was not determined.

To note the position of engine on the curve at the various positions of the boiler as shown by tabulated statement, a section of the curve was drawn at 3-inch scale and a tracing made of plan of engine and plan of the truck, which showed that the back driver and truck flange bore against the outer rail, while the front flange cleared with the 6⅝-inch hanger at the 18-degree angle, with a boiler movement of ⅝ of an inch. With a boiler movement of ¾ of an inch and over, the front driver flange came in contact with the rail, and with the maximum movement of the boiler as recorded, the back driving wheel flange bore hard against the inside rail of the curve, and the front driving wheel flange and truck flange bore hard against the outside rail, thereby confirming the record of the road tests and our conclusions that the angle of the hanger giving the minimum flange stress with the minimum boiler movement to be the proper angle to use.

It will be noticed by the tabulated statement that the angles giving the best results for the two hangers in this test were 18 degrees for the 6⅝-inch hanger, and

28 degrees for the 8-inch hanger, which leads the committee to believe that the angle of the hanger should be changed for each length of hanger used.

While the results obtained from these tests are very interesting, and may be said to be conclusive for a locomotive of the type used and under the conditions under which the tests were made, your committee feels that sufficient information has not been secured to enable them to answer conclusively the question propounded, and believes that to do so will necessitate making a series of tests with the different types of engines for which the information is desired under different conditions as to gauge of track, degrees of curvature, etc., and if the Association feels that it is desirable to pursue this investigation further, that it would be advisable to set aside a sufficient amount of money to defray the expenses of making such tests, as the expense incident to making such elaborate tests will be considerable, and it would not be right to expect any railroad company to make them at its own expense.

Respectfully submitted,

G. L. POTTER,
M. N. FORNEY,
W. GARSTANG,
W. LAVERY,
JOHN MACKENZIE,
Committee.

FORT WAYNE, Ind., June 1, 1897.

THE PRESIDENT: Gentlemen, what is your pleasure in reference to the report of the Committee on Truck Swing Hangers?

On motion of Mr. Herr, the report was received and opened for discussion.

THE PRESIDENT: Gentlemen, you will please consider Mr. Quayle as occupying the chair.

THE CHAIRMAN (Mr. Quayle): Gentlemen, if there is no one to discuss this subject just presented we will proceed to the next topic.

MR. VAUCLAIN: I move, as the time has been somewhat wasted already this morning, that we suspend discussion of this subject and proceed to the next one. (Seconded.)

MR. FORNEY: Before that is put, I would move as an amendment that the committee be discharged.

The amendment was accepted by Mr. Vauclain, and the motion as amended was carried.

THE CHAIRMAN: The next subject is that of Locomotive Grates. Mr. H. Wade Hibbard is chairman of this committee.

MR. HERR: I notice that the last report was read entire. I believe a motion prevailed this morning to read the reports in abstract. I think we would save considerable time if that practice were followed.

THE CHAIRMAN: I am informed by our Secretary that Mr. Hibbard is prepared to read the report in abstract. Mr. Hibbard, you will please come forward.

Mr. Hibbard presented in abstract the following report:

REPORT OF COMMITTEE ON LOCOMOTIVE GRATES.

To the President and Members of the
American Railway Master Mechanics' Association:

Your committee, upon the subject, " What kind of grate is the most suitable for burning anthracite coal — the cast-iron shaking, or the water-bar?" begs leave to submit its report.

The Erie and Pennsylvania Railways prefer the transverse cast-iron shaking grates, without any water bars, on all classes of locomotives.

The New York, Ontario & Western prefers the transverse shaking grates for the central two-thirds of grate and water tubes along the sides, for fire boxes over drivers.

The Lehigh Valley prefers the longitudinal shaking grates with one or two water tubes separating shakers.

The Delaware, Lackawanna & Western uses water tubes for fire boxes over drivers, but prefers shaker fingers between water tubes for narrow fire boxes.

The Delaware & Hudson and Philadelphia & Reading Railways prefer water tubes in all classes of locomotives.

It appears in brief to your committee that a grate should be composed wholly of cast-iron shakers for fire boxes not over the drivers.

For wide fire boxes, those extending out over the drivers, using lump coal, transverse shakers alone, or longitudinal shakers lightened with water tubes between, are recommended.

For wide fire boxes over the drivers using small coal, shakers appear to be preferable in whole or in part.

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WATER TUBES.

1. The earlier locomotives in which attempts were made to use anthracite were rather deficient in grate area. The burning of this refractory fuel was not well understood and these small grates compelled the use of a high grade of coal in order to produce sufficient steam. This is stated by the Reading to have caused the burning out of the cast-iron grate bars then used because of the lack of ashes to settle upon them and protect them. The use of anthracite was consequently not really successful until water grate bars were designed. These were put in by James Milholland, as shown by Plate 1, from the Philadelphia & Reading Railway. It is further stated by this road that no further trouble was had with melting of grates; and with proper design to give pitch enough to secure circulation, and reasonable care as to removal of washout plugs at ends of tubes and washing out the tubes when boilers are cleaned, it is stated that tubes are entirely satisfactory.

It is the general experience of the Delaware & Hudson also, that tubes are satisfactory, if kept washed out and ash pans kept clear of hot ashes. Mud-bound tubes are destroyed as soon as circulation ceases. With the New York, Ontario & Western, attention is called to the greater first cost of the tubes and the unhandy manner of cleaning the fire while running. By the Delaware, Lackawanna & Western complaint is made of tubes buckling up out of fire. The experience of the Erie, Lehigh Valley, and Pennsylvania agrees in showing that the tubes are unsatisfactory because of warping and splitting due to corrosion, mud, and scale; labor in fitting the tubes and in their maintenance, loosening or drawing out of the sheet requiring repeated calking and thus injuring the fire-box sheets. The Lehigh Valley reports tubes as fairly satisfactory in good water districts, if properly cared for, and regularly washed out; but, as on the Erie, when transfers of locomotives are made to bad water districts, the cast-iron shaking grates have been far superior to water tube grates. In no case has the Erie found tubes to be superior to shakers. It is more convenient to have tubes in narrow fire boxes than in fire boxes over the drivers as regards the pull-out bars, for in the former the coal space on the tender as usually designed permits of the proper withdrawal of the pull-out bars when it is desired to clean the fires. The narrow fire boxes also afford better opportunity for inclining the tubes.

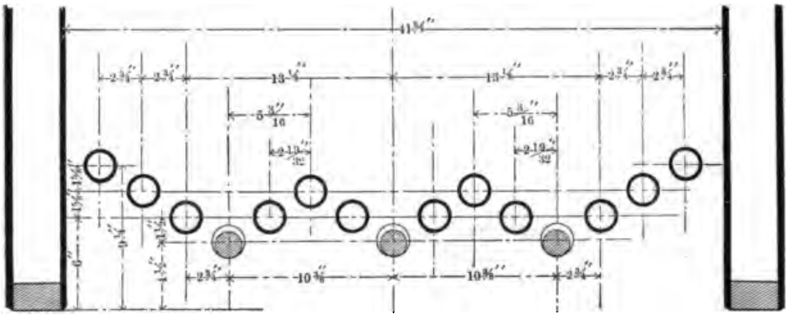


Plate 1

Milholland Grate.

Philadelphia and Reading Railroad.

See Sections 1 and 11

2. *Closing up of tubes*, by accumulation of mud, with the resulting overheating and burning, appears to be common, even where the greatest precautions are taken in washing out.

The Pennsylvania reports that it washes out the tubes weekly. Its slope is one inch per foot, which ought to be enough for circulation. The front is screwed and the back ferruled and easy to slip. It adds: "Although we are very particular to have all the plugs in the fire-box leg opposite the water bars removed once a week when boilers are washed, in order that the tubes can be thoroughly cleaned with a water pressure of about 100 pounds, we have taken out tubes that were almost closed, notwithstanding our care, and under these conditions the tubes often become overheated, warp out of line, crack, open up at the joint and otherwise give way." Sometimes a large piece of scale is found to have fallen over against the end of a tube, thus completely shutting off circulation.

3. *Tubes rising up out of the fire* is a prominent difficulty and is acknowledged by all but one of those even who prefer the tubes to the shakers. The Pennsylvania never has bars rise up unless they have been closed or nearly so with mud and scale. The Lehigh Valley and Ontario had more trouble when their slope was $\frac{3}{16}$ inch and ⅝ inch in 12 inches, respectively, and attribute it to insufficient slope. The latter has no trouble with 2 inches in 12 inches. The ends of their tubes had freedom to slip. On the other hand, the Delaware, Lackawanna & Western did not wholly obviate the rising up of tubes by increasing the ¾ inch in 12 inches slope, but the tube ends were not free to slip. The Erie believes that the circulation increases the nearer

tubes are placed on a perpendicular, yet states further that brick-arch supporting tubes, inclined at forty-five degrees, have become solid with scale, and have burst as often (proportionally to their number) as tubes having only eight or ten degrees pitch—2 inches in 12 inches. This apparently indicates that, however great their slope, water tubes are not self-freeing from mud and scale. The Delaware & Hudson experience is that the more slope that can be given the better. Although it has had very little trouble with tubes rising, yet such rising always indicates mud in the tubes or an ash pan full of hot ashes beneath.

The Delaware, Lackawanna & Western, while still using water tubes on all engines, is unable to prevent the rising of the tubes. It was distinctly stated that that road wants it understood that this happens on new boilers with new tubes as well as in old and partly corroded ones. Some buckled tubes that are taken out are perfectly clean. It assumes that the trouble is caused by the fire driving the water out of the tubes, and as the bottom of the tubes is exposed to the air the tubes naturally spring upward. It was observed that in the fire boxes over drivers the outer tubes more often buckled than the middle tubes. It is thought that the mud ring springs outwardly at the middle and thus allows tube expansion and prevents the buckling. Throwing ashes on the tubes before lighting the fire also prevented the trouble. With fire boxes over drivers where cast-iron filling pieces are used with the water tubes, they formerly left the top of the tube ¾ inch above the cast-iron surface, but reduced this to ½ inch with good results. (The Ontario makes it one inch.) The precaution is necessary to keep all air spaces through the grates uniform, so that the draft and fire will be evenly distributed.

4. *Standard Slope* varies on different roads, but in general is about one inch in twelve inches. The Lehigh Valley uses ¾ inch in twelve inches. The Ontario prefers the greater rather than the lesser slopes; but regards the length and width of fire boxes as having a great deal to do with slope, and the depth from fire flues to water tubes more. Sufficient slope is, of course, needed for circulation in preventing the water from being driven out of the tubes. In fire boxes over the drivers, with cast-iron filling pieces, as in Plates 4, 5 and 6, or with shakers, tubes and filling pieces, as in Plate 16, the Ontario uses a slope of $\frac{11}{16}$ inch in twelve inches.

5. *Tube End Attachment.* Plate 2.—On account of the length of tubes the expansion and contraction due to changes of temperature must be provided for by a slip joint as for surface condenser tubes. Plate 2, Fig. 1, shows the threaded front end preferred by all except the Delaware & Hudson, whose design is the same for both ends, namely, as per Fig. 2. There is no wash-out plug at the front end of tube. Fig. 3 gives the Pennsylvania attachment with wrought-iron taper ferrule, the tube being turned to allow free sliding through the ferrule.

Fig. 4, with tapered copper ferrule, is a construction approved by the Schenectady Locomotive Works for either or both ends. The tube is not expanded and there is freedom for end motion. The Lehigh Valley drives the taper copper ferrule from the water side and does not expand the tube. The hole in back outside head sheet is made large enough to insert ferrule. This has given no trouble. If at any time the ferrule needs tightening, the wash-out plug may be removed and a few light blows on the large end of the ferrule are sufficient. Fig. 5 shows an excellent attachment, having malleable iron taper thimble, with slot to allow compression for hug-

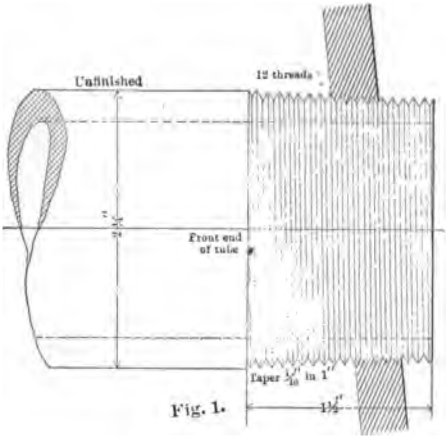


Fig. 1.

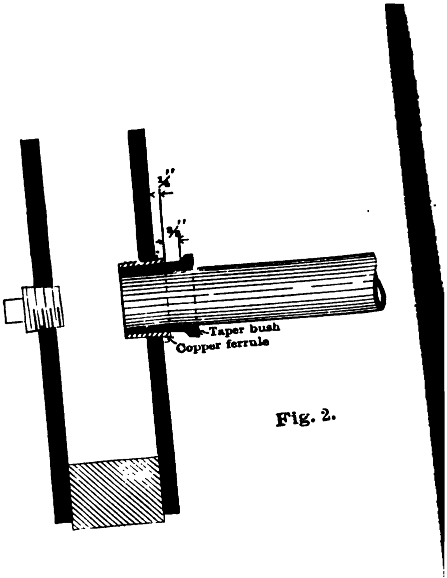


Fig. 2.

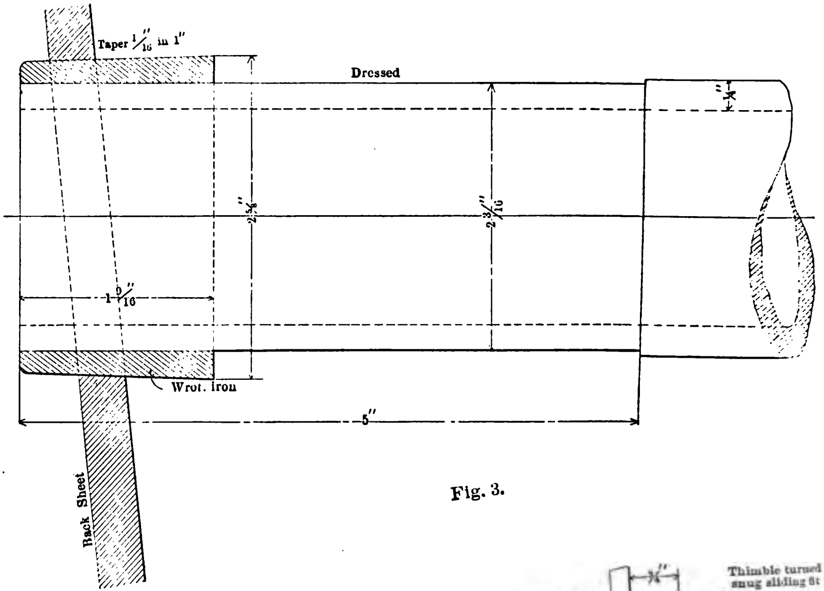


Fig. 3.

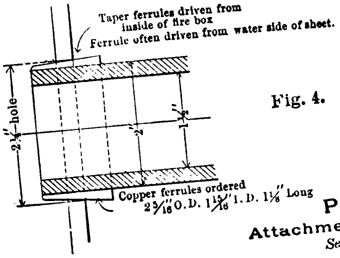

Taper ferrules driven from inside of fire box
Ferrule often driven from water side of sheet.
2¼" hole
2"
1½"
Copper ferrules ordered 2 3/16" O.D. 1 15/16" I.D. 1⅛" Long

Fig. 4.

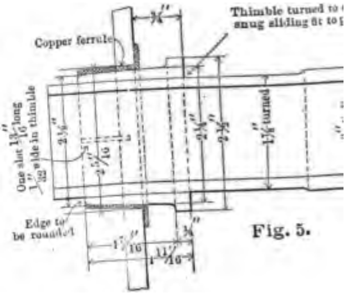


Fig. 5.

Plate 2.
Attachment of tube ends.
See Section 5.

ging the tube more closely. The copper ferrule is flanged over against fire side of plate. The tube is, of course, not expanded.

The Erie was accustomed to expand back end, rolling and caulking it into a thimble, and occasionally even beading one or both ends of tube. The Ontario expands the back end of tube into a copper ferrule through the outside shell, in addition to turning off the tube straight. The Philadelphia & Reading does the same, "like calking a fire flue with copper ferrule, but without beading the flue over." The Delaware, Lackawanna & Western has been using a copper ferrule and spreading the end of the tube by a taper mandrel. These last four methods, where tube is expanded, are not desirable because preventing free end movement. The Erie used the method also of tapping the back sheet with taper tap and screwing in a hollow conical sleeve of soft brass. This would closely clasp the tube, which was turned straight, when screwed hard into the taper hole. The Erie also used the Lehigh Valley method, but beaded the copper on the fire or small end to hold it in place. This beading is not found necessary on the Lehigh Valley.

The Delaware, Lackawanna & Western has now been trying for one year the method of Fig. 5, at the committee's suggestion, in hopes to prevent the buckling of tubes out of the fire; but though many of its tubes are secured by this new method, "not the least benefit is derived therefrom. They rise up just as freely as those fastened by the old method."

6. *Corrosion of tubes.*—The Pennsylvania states that it has been quite a common occurrence to have tubes leak at the front and back sheets, and sometimes it is quite difficult to keep a tight joint. When a leak is once sprung it is often found difficult to get the joint tight. It is often found that corrosion has taken place around the joint and to overcome the leak is still further made difficult. Sometimes a sheet has been calked so much at the tubes that it has been necessary to put on a patch the full width of the fire box. The Delaware & Hudson has mine water that eats out the tubes; the Delaware, Lackawanna & Western, not enough to cause much trouble; Lehigh Valley no trouble except in bad water districts; no trouble on the New York, Ontario & Western.

7. *Abrasion of tubes.*—The Erie has had some tubes fail through abrasion. There is also some slight trouble on the Delaware, Lackawanna & Western and Pennsylvania. The Ontario, Delaware & Hudson, and Philadelphia & Reading report no trouble.

8. *Corrosion of side sheets* is caused by an undisturbed lodgment of ashes against the sheet and is particularly facilitated if there is also a leak.

The Pennsylvania states: "We have had considerable difficulty with corrosion of fire-box sheets, due to the lodging of ashes. This has not been confined to any particular style of grate, but has, perhaps, been somewhat more numerous with water grates. It may, however, have been due to construction of ash pans, which permitted ashes to back up, covering rivet heads in mud ring." The Ontario knows of no arrangement to overcome the difficulty due to the accumulation of ashes; shaking grates and water tubes being about the same in this respect. The Erie regards the trouble as somewhat less with tubes than with the side bearers of transverse shakers, owing to tubes presenting a smaller area. It is added that a pull-out bar should be placed adjacent to the side sheets to drop the ashes there frequently. The Delaware & Hudson has trouble only when there is a leak.

9. *Pull-out bars* are not recommended to enter front water leg. They are usually in the proportion of one bar to two tubes, though the Delaware & Hudson uses about one to three. This is obtained by placing only two tubes together, but where a bar is placed as above next the sheet the proportion becomes one to three.

The Pennsylvania reports that the pull-out bars quite frequently warp, bend or break, giving them much trouble. An ingenious use is made of this warping by some firemen; the lever, provided for loosening and pulling out the bar, is put on the end and the bar rotated, thus giving a little of the shaking grate effect.

The Pennsylvania and Lehigh Valley formerly used a drop bar, or "tumbling dead bar"; the former upon narrow fire boxes, the latter upon both narrow fire boxes and those over the drivers. This was fairly satisfactory. It did not project above the tube surface, was pivoted lengthwise beneath the tubes, and rotated down out of the way so as to permit of cleaning the fire.

10. *Supports for water tubes and bars* are formed by cross braces whose ends are attached to the mud ring. The Erie states that there should be one intermediate support for fire boxes six to seven feet in length; two supports for fire boxes from seven to eleven and a half feet long, which may be spaced unequally if necessary to clear drivers. In the longer fire boxes, if the front end of pull-out bar does not enter front water leg, it should be supported there also. Upon Plate 3 at A such a front bar support is shown attached in this case to the frame. At the rear the thimble in water leg, through which the pull-out bar passes, should be reinforced inside as at A, Plate 15, to allow for wear of bar; or else there should be a cross support there attached to mud ring. Long fire boxes must have the mud ring braced across from side to side to prevent spreading, and this furnishes an easy means for intermediate support of tubes and bars. To this cross brace a cast-iron piece in one to three sections is bolted, its notched upper edges holding the tubes and bars.

Wide fire boxes over drivers require a support made light by combining a 2½-by 3-inch square horizontal bar with a 1¼-inch truss rod having nuts at both ends.

11. *Plate 1* shows a *zigzag cross section* of grate that has proved successful on the Philadelphia & Reading, and is preferred by the Delaware, Lackawanna & Western on narrow fire boxes. The latter says: "The water tube farthest from the pull-out bar should be the highest, and the bar on the lowest elevation. This admits of more readily cleaning or dumping the fire, as the ashes and the cinders will roll off to the lowest point, or on the pull-out bar, from which they will drop when it is pulled. It also makes possible smaller openings perpendicularly through which coal may drop and still leave sufficient area of opening for draft between the bars" The Delaware & Hudson gains somewhat of the same ease, though with level water tubes, by having the pull-out bar considerably below the level of the tubes.

12. *Plate 3* shows a *transversely level* water grate, as designed by the Schenectady Locomotive Works for a narrow gauge engine; but the principle is common, and for all widths. Though the tubes are arranged level transversely, the pull-out bars are usually slightly below their surface, as shown. Occasionally the pull-out bars are placed as much as two inches below the tubes.

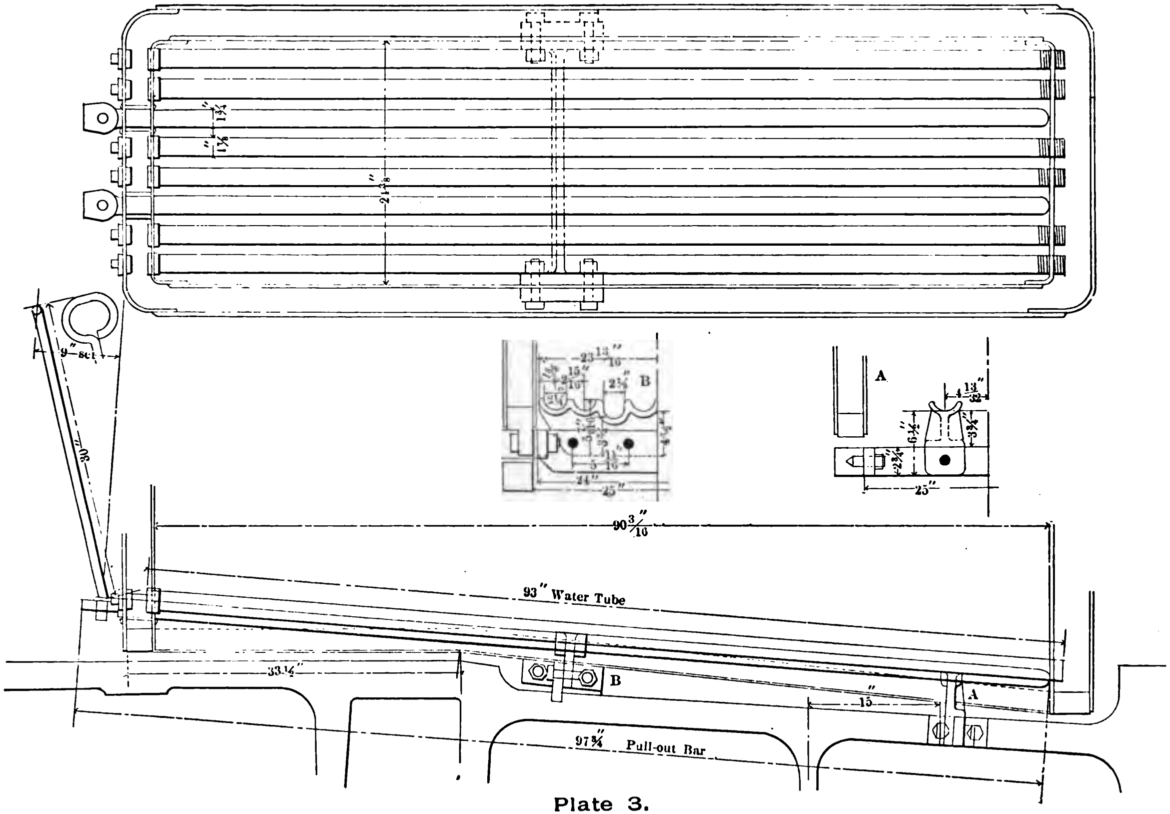


Plate 3.
Water Tube Grate with pull-out bars.
Schenectady Locomotive Works.
See Section 12.

TUBES WITH FILLING PIECES.

13. *Tubes with filling pieces* are illustrated by Plates 4, 5, and 6. "The Erie's experience with this combination has not been satisfactory, and engines having this form of grates have been fitted with shaking grates. It was used in engines having either the true Wooten or plain fire boxes over the drivers. There were four drop grates," A 20 on Plates 4 and 5 being the Reading design, "two in front and two behind, in line with the fire doors. Cleaning the fires was difficult and slow," in which the Lehigh Valley and Ontario concur, "and the volumes of cold air which entered the fire box when the drop grates were opened, proved very injurious to the flues."

The Lehigh Valley found them unsatisfactory on account of the cast-iron filling pieces and drop grates burning off. The Ontario states that "the defects in this grate were mainly on account of the tubes being nearly level; therefore they become stopped up with mud and scale, causing them to burn out or break. The excess in first cost, and delays in making repairs, are also detrimental to their favor."

The Delaware & Hudson, whose design is identical with that of Plate 6, states that slaty lump coal will form large clinkers, which fill the small spaces of the cast-iron filling pieces, preventing the proper supply of air for combustion. When water tubes are kept clean and free from mud, fine coal can be used. In general the experience of the Delaware & Hudson is favorable to this design when burning pea coal.

The Philadelphia & Reading has entire success with the designs of Plates 4 and 5 and replies as follows: "The water tubes are put in at intervals of 4¼ inches across the fire box, and the intervening spaces filled in with the cast-iron pieces sufficiently fine to contain the fine anthracite without waste. They are found to work entirely satisfactorily, and we have never had any trouble with water bars in accordance with the numerous questions asked in relation thereto. For instance, we give these bars a sufficient pitch to insure circulation, consequently we have had no trouble with the bars springing up." All sizes of coal are burned upon this grate, but it is particularly appropriate for pea and buckwheat. The Delaware, Lackawanna & Western uses nothing else in the fire boxes over drivers. The cast grates occasionally have to be replaced and at times there has been trouble with water tubes rising up in the fire. From two to three cross bearers are used for cast filling grates, which act as supports for water tubes.

14. Plates 4 and 5 show the lock used to hold the drop grate level, the wrought-iron rod which operates the drop grate passing beneath an adjacent tube and being keyed to its two drop grates.

15. Plate 6 shows an entirely different arrangement of drop grates. A variation is used by the same road, in having the drop grates in the front two-thirds of the fire box. The beveled top of cross supports and the beveled end of the grate bars permit free longitudinal expansion. The New York, Ontario & Western uses the arrangement of Plate 6, except that the bell-crank is connected to the drop grate by a short link instead of roller.

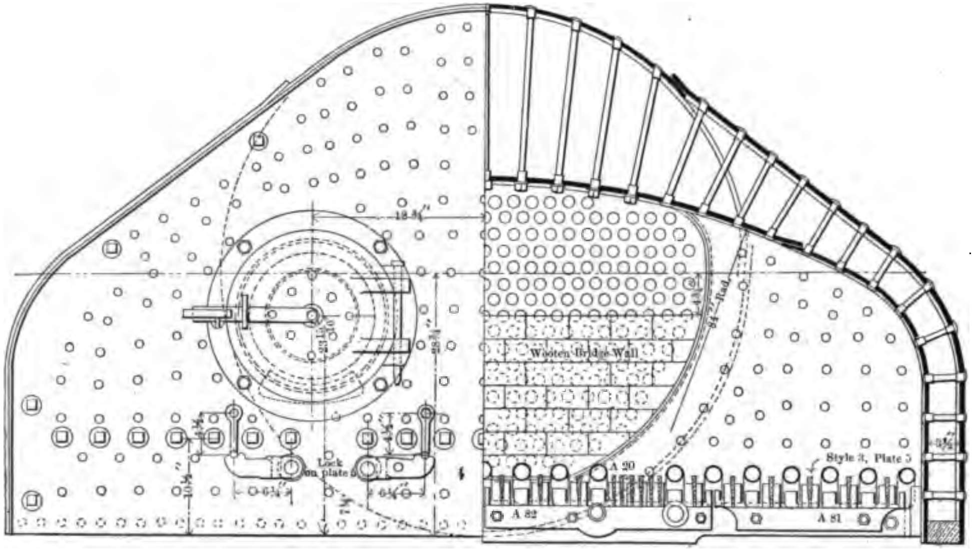
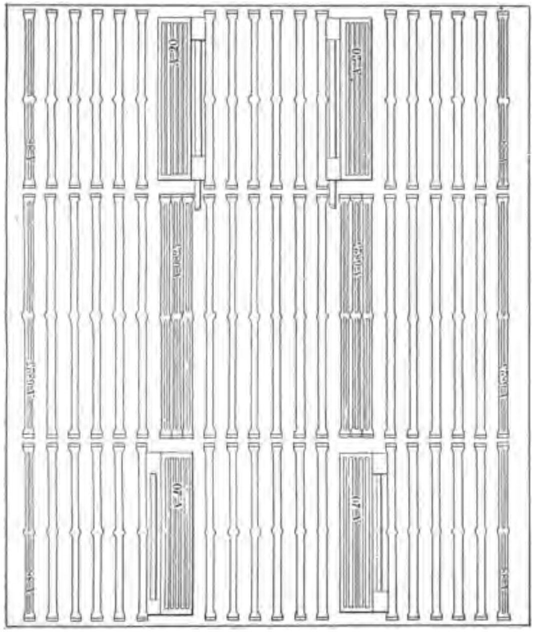
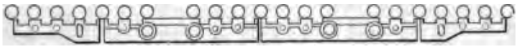
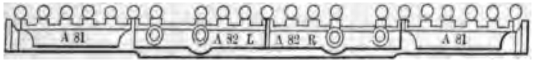


Plate 4
Wooten Fire Box
Philadelphia and Reading Railroad
See Section 14

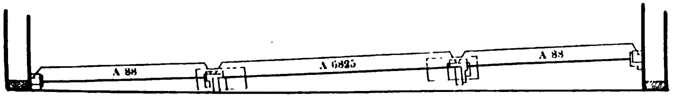




Arrangement of front and back bearers



Arrangement of front and back cross bars



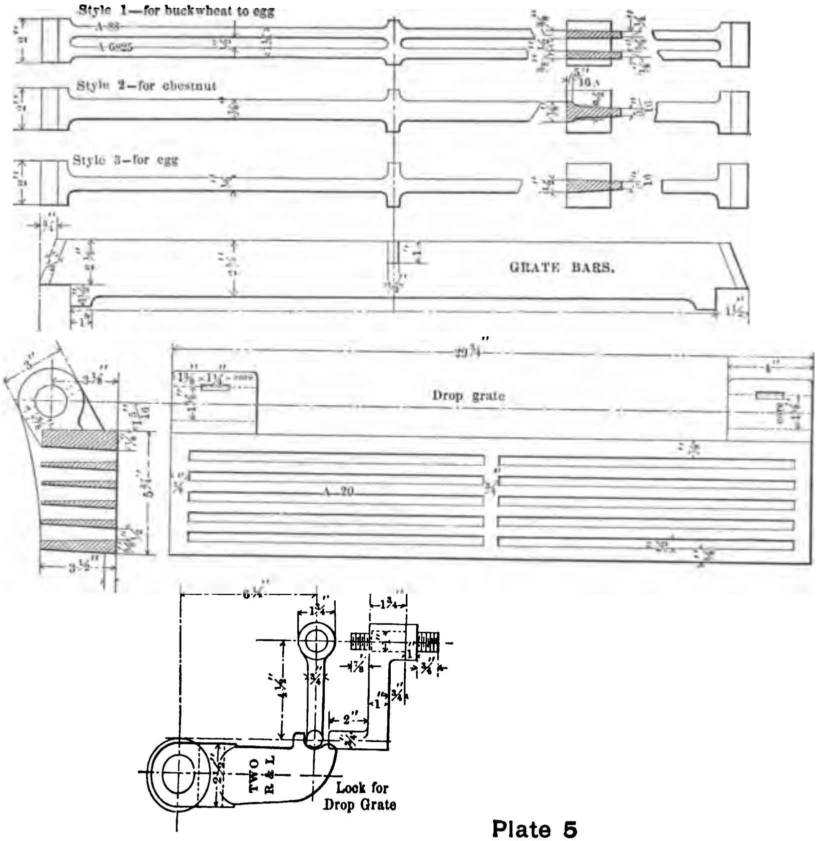


Plate 5

Grates, drop grate, and drop grate lock of Plate 4

Philadelphia and Reading Railroad. Reading Pa. 1893.

See Section 14

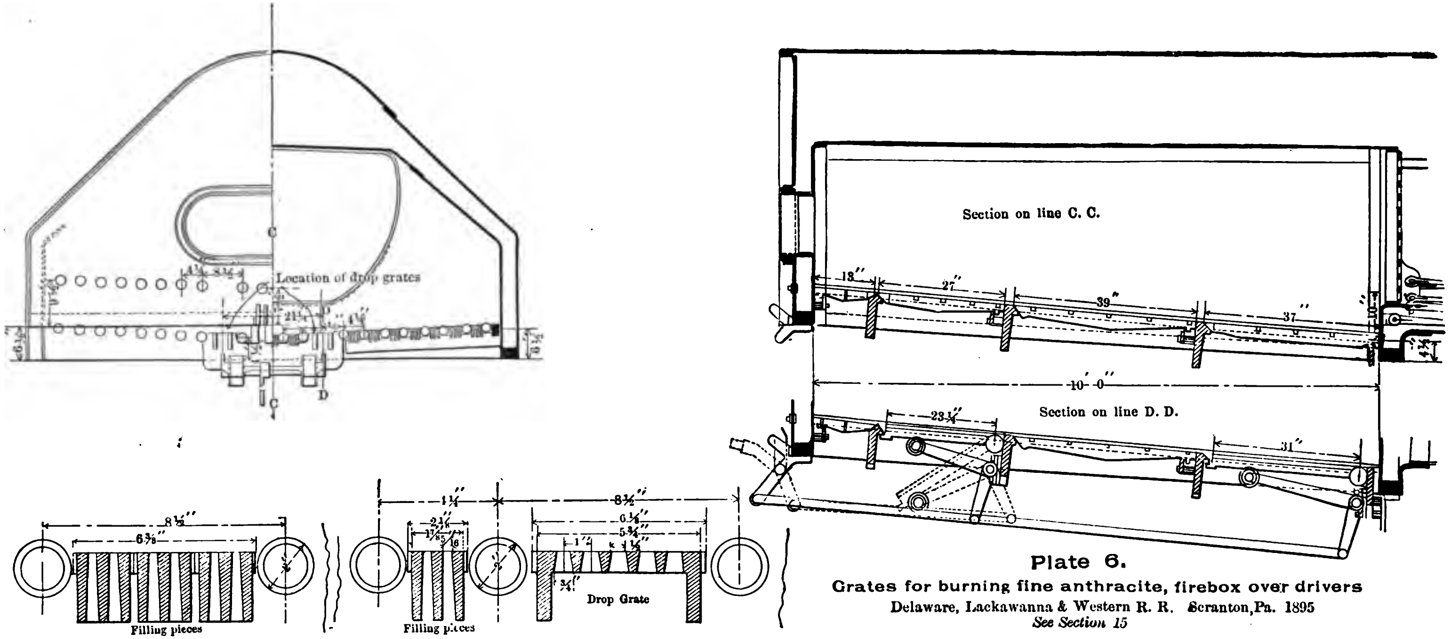


Plate 6.

Grates for burning fine anthracite, firebox over drivers

Delaware, Lackawanna & Western R. R. Scranton, Pa. 1895

See Section 15

TUBES WITH SHAKER FINGERS.

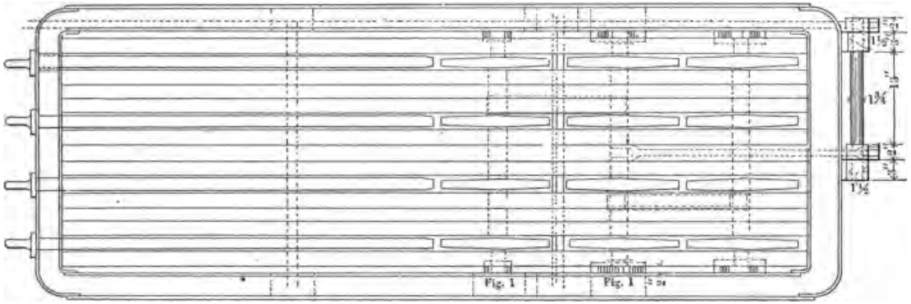
16. *Water tubes with transverse shaker fingers and pull-out bars* ***between,*** as shown on Plate 7, are entirely successful on the Delaware, Lackawanna & Western, which uses the combination on passenger engines only. A description is given that "these shaking grates occupy half of the front end of fire box and have cast fingers which work between water tubes. There are pull-out bars for the remaining portions of grate which occupy the space in the back between the tubes that the shakers do in the front part of the fire box. At first shakers were tried between water tubes the whole length of the fire box; but it was found that it was not necessary, since shakers as now used in front are sufficient. They give good results in passenger service on long runs, where it is necessary to stir up the fire in front end of fire box." There is little or no trouble with the fingers warping and burning. A different form of support, also used on the Delaware, Lackawanna & Western, is shown in Fig. 2, Plate 7, as attached to the ash pan. The Schenectady Locomotive Works also designs a long side bearer, located as in Fig. 2, but with back end supported on cross beam and front end by brackets bolted up under mud ring.

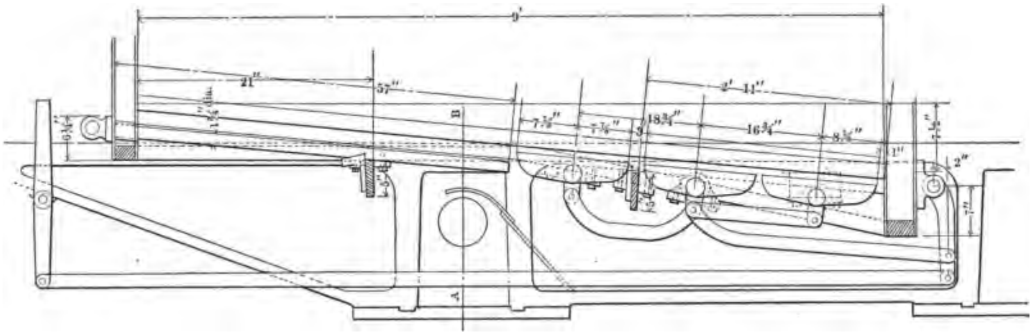
Inquiries upon other roads elicit the information that the Lehigh Valley and Ontario never tried anything of the sort. The Erie and Delaware & Hudson have done so, but gave it up because of the short life of the fingers which came up into the fire.

SHAKING GRATES.

17.. Technical literature appears to be singularly lacking in the history of the details of the use of anthracite in locomotives, but your committee learns that it is only within the past decade or less that the railroads of this country have been making any efforts to use shaking grates. Their most extensive use today is to be found on the Erie Railway, their adoption dating from the early part of 1890. Before this time, water tubes with pull-out bars had been used and were a source of continual trouble. The Erie has now very few locomotives thus equipped. Upon these will be applied, whenever renewals are necessary, either the standard 40-inch cast-iron shaking grate (as shown on Plate 8); or a somewhat shorter 32-inch standard grate of same width and general design, with ½-inch fingers and ⅜-inch openings for pea coal, and thicker cross ribs of 4½ inches maximum depth, used for fire boxes over the drivers. The Erie has found no defects in shaking grates.

18. *The general experience* of the Erie, Lehigh Valley, New York, Ontario & Western, and Pennsylvania (fire boxes between drivers only), causes them all decidedly to approve of the shaking grates in comparison with their former water tube grates. The Delaware & Hudson considers that they "give good service in all classes of fire boxes when fine coal is used, but troublesome when lump coal is used, by melting and warping the grate bars. Water grates were adopted to obviate the difficulty." The Schenectady Locomotive Works states that "some roads are using the ordinary cast-iron grate with hard coal as well as with soft, and when the grate bars are designed to give the additional strength required to stand the heat of a hard coal fire and in the ash pan, there seems to be no doubt that the cast-iron rocking grates are as good in all respects as the water bars, and have points of considerable advantage."





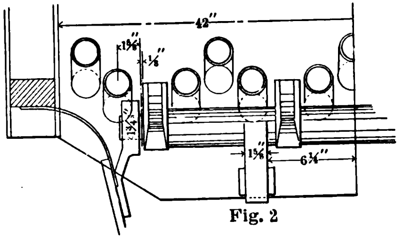


Fig. 2

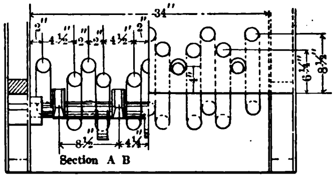


Fig. 1

Plate 7

Water tubes with transverse shakers, and pull out bars, for lump anthracite.

Delaware Lackawana and Western Railroad.

See Sections 16, 36

19. *Against the shaking grate* is its weight (Section 21) as compared to water tubes; also in some fire boxes over the drivers the necessarily shallow portion of the ash pan at the sides has upon some roads caused the burning (Sections 22-25) of the shakers located there because of the accumulation of hot ashes, and brought about the substitution of water tubes at that particular point.

20. *The advantages* of the shaking grate, in addition to an avoidance of the disadvantages of water tubes mentioned in Section 1, are stated by different roads as follows:

Cleaner and thinner fire and softer exhaust (Section 26).
The improvement of the fire during very long runs by stirring from beneath (Section 27).
Quickness and small labor in cleaning fires at stops and terminals (Section 28).
Ability to use cheap coal having a great amount of refuse (Section 29).
Economical use of coal (Section 30).
Less harmful effect on fire-box sheets (Sections 8 and 37).
Less first cost.
Simplicity, as regarded by the Erie.
Greater safety, since there are no tubes to burst, no sheets to be injured by rolling and calking, and no unexpected breakdowns.
Durability with less careful handling.
Less expense to keep in good condition.
Advantage in poor water districts, since water has no effect.
Quickness and cheapness of repair (Section 32).

21. The *weight* of longitudinal shakers, as shown on Plate 15, if without intervening tubes, is four or five times as much as the weight of water tubes and pull-out bars. This has led to the introduction of one or two tubes between shakers, solely on grounds of lightness.

22. *Warping and burning* of shaking grates has given very little trouble to the Erie, using transverse grates shown on Plates 8, 9 and 10, and very similar to 14, and where it has occurred it has been due largely to neglect on the part of the firemen in returning the lever to proper position, thus allowing the edge of grate to be overheated. Lumps of clinkers will also become wedged between the edges of adjacent grates, displacing them and allowing the incandescent fuel to fall into the ash pan, and, if that is too full, to burn the grates. Grates should be made heavier and with stiffer fingers for anthracite than for bituminous coal. See Section 38. For pulling out the bars of warped longitudinal grates, see Section 32.

Plate 11 shows an anthracite and a bituminous grate for the same engine. The Delaware, Lackawanna & Western has had no trouble with shaker fingers between tubes, as shown on Plate 7 and described in Section 16, yet these are certainly more exposed to burning off than any of the other types of anthracite grate illustrated. The Pennsylvania has had "comparatively little trouble," much less than with the tubes. The grates have broken occasionally, due to weakening by burning, or sometimes to unknown causes. It has been an occasional experience on the Erie to find a broken grate due to its being struck underneath by the stream of cold water used to clean out the ash pan.

The Lehigh Valley and Ontario have no trouble when the ash pans are not allowed to fill up, especially at the shallow sides. This is particularly important where ash pans are over drivers. To obviate this difficulty, ash pans should be as deep as possible and the grates should be held level, while running, by positive means. This brings us to the subject of

23. *Locks.* These should be so designed as to compel a careless fireman to bring the grates back to the level position. It is not enough that he should be able to know that they are level. A lock for doing this is shown on Plates 8 and 9, where the hinged lever B will be kept projecting out into the fireman's way until he has brought the grate to a level. The vertical shaft, having a crank A at the lower end attached to the grate and a lever pivoted at the top for a handle, has a projection on the upper bearing of the shaft which engages a clevis on the lever when the grates are in the level position and retains them so until the lever is raised to a horizontal for shaking. Upon Plate 11 is a similar device with a more simple lever.

24. When short vertical levers, as on Plates 13 and 14, operated by a detachable bar, are used, a means of holding the levers in position is to drill a ¾-inch pin hole in each lever above or below the fulcrum point, to correspond with a similar hole in the fulcrum casting usually attached to the lower part of water leg. When the shaking operation has been completed, the lever is placed in proper position and a pin introduced through the hole in it, the fulcrum casting thus preventing the grates moving. This is used upon the Erie also. Without a changed design, however, a careless fireman may not leave the lever properly placed, or may not insert the pin.

25. Longitudinal shaker locks are commonly like the four center ones, A 8 on Plate 15. The wrought-iron pivot bar, S 22, keyed to the shakers, has a square back end for the shaking lever. A drop swing lock is provided to engage this square and to prevent its turning of itself. This bar should be designed with a square projecting wing on the under side at the lock, so that it can be locked when the grate is right side up only. It would doubtless be easy to design the lock support so that the grate would have to be brought back to a level before being able to remove the lever. Attention is called to the right and left outer bar locks, the supports A 1 and A 2 bolted to the boiler being constructed so as to permit the shakers to be tilted only toward the center of the ash pan in an endeavor to keep its shallow sides clear of ashes.

26. That a *cleaner and thinner fire*, as well as a softer exhaust, can be used with shaking grates, is the experience of the Pennsylvania. The great number of small openings, instead of longitudinal openings running the entire length of the fire box, prevents much of the small coal shaking through. The Ontario also considers that a thinner fire can be carried on shaking grates, while the Lehigh Valley and the Erie in general see no difference, though some of the latter's Master Mechanics have found the Pennsylvania and Ontario experience to be their own. The softer exhaust required would naturally decrease the cylinder back pressure, and thus increase the power of the engine.

27. *Shaking while running* is regarded as a very desirable quality of shaking grates on long and severe runs, by the Erie, Lehigh Valley, New York, Ontario & Western, Pennsylvania, and Delaware, Lackawanna & Western (tubes with shaker fingers between). This is particularly true of fire boxes between drivers, and even the latest design on top of frames with thirty-three square feet of grate surface in heaviest express service upon a comparatively level division is not as satisfactory where the last half of a hundred-mile run west is level, as when opportunity is given, on the east-bound run after fifty miles, of reviving the fire by taking advantage of slight

grades to use the shakers "for cleaning the under and dead part of the fire without disturbing the surface." The Erie passenger engine with fire box on top of frame having thirty-nine square feet of grate, does not vary appreciably in steaming at any point of a run. The Delaware, Lackawanna & Western states that one lump coal engine, having thirty-six square feet of grate, makes a continuous and fast milk train run of 142 miles, with thirty-nine stops, without once cleaning the fire, either with tool or shakers. "This feat can only be accomplished by very judicious firing." The Delaware & Hudson, with no shakers, states that "as a rule our engines do not steam as well after seventy-five miles by raking the fire above."

Shakers do not appear to be so necessary for keeping up steam on fire boxes over drivers. Fire boxes without shakers, but having eighty square feet of grate surface, are good steamers for runs of 142 miles in length, and those with shakers having sixty-three square feet of grate, are also good steamers for 150 miles.

"Tight ash pans," replies the Erie, "are preferable to the other forms in the event of cleaning the fire or shaking the grates while running, as by this means the ashes are prevented from getting on the machinery or in passenger cars, and the chances of fire along the track or bridges are materially reduced." The ash pan door is made of sheet metal hinged at the top. The Lehigh Valley approves them "if arranged so that they can be opened after cleaning the fire, to admit necessary draft under the grate." The Pennsylvania considers them a necessary adjunct of shaking while running. Its door is made of ribbed cast iron, sliding vertically in cast-iron guides, and counterbalanced. It keeps tight, since it does not warp, and this is believed to be very desirable in order to regulate the air supply.

28. *Quickness and ease in cleaning* fires, in these days of time being money, is prominently mentioned in our replies. The Ontario finds that a fire can be cleaned upon shaking grates in one-fourth the time taken upon water tubes. This is a usual experience, and the saving of labor on the part of the firemen is returned in his better work in other more important ways.

29. *Cheap coal* can be better used upon shaking grates because the great amount of ash and refuse is easily removed while running. One branch division uses coal of even twenty-seven per cent ash upon passenger engines with fire boxes between frames and with shakers. Such coal in so small fire boxes does not give free steaming, but it is referred to as showing what can be done with shakers. Anthracite railroads are finding it necessary sometimes to use slaty coal, which they have mined but cannot sell, or which must be purchased from heavy coal shippers; also in common with all roads, they have some inexpert firemen who need every advantage to make steam even with good coal.

30. *Economical use of coal* is reported by the Erie, Lehigh Valley, and Pennsylvania, due to less loss by dropping through the grate and less loss when cleaning fire. The opinion of the New York, Ontario & Western Railway had been that there was a considerable saving by the use of shaking grates over water bars under like conditions of coal, service, and engine crew; but the series of tests which have been carried on by the committee, made possible by the kindness of the above road, have not demonstrated this saving. There is more difference in crews than in grates.

Test 1 was with *slaty lump* coal upon 25½ square feet of grate *between frames*, as shown in Plate 13. The runs were 77 miles in length, with four passenger cars, at an average speed of 32.9 miles per hour. Each engineman made ten runs with Engine 73 and six runs with Engine 78. The following are the average results:

	ENGINE NO. 73. SHAKING GRATES.			ENGINE NO. 78. WATER GRATES.		
	Crew No. 1.	Crew No. 2.	Average.	Crew No. 1.	Crew No. 2.	Average.
Pounds coal per car-mile	15.7	14.	14.8	16.4	14.8	15.6
" water per pound coal	5.1	5.2	5.15	5.	5.4	5.2
" coal used in cleaning fire	458.	407.	432.	460.	366.	413.
Maximum boiler pressure	......	......	143.	......	......	145.
Minimum boiler pressure	60.	100.	......	75.	75.	......
Average boiler pressure	131.4	132.	131.7	124.6	126.	125.3
Coal per square foot grate per hour, used while running	81.	72.4	76.7	84.6	76.5	80.6

Test 2 was with *fine* anthracite upon 80 square feet of grate *over drivers*, as shown in Plate 14. Eight freight runs of 77 miles each were made by each engine at an average speed of 14.5 miles per hour. The following are the average results:

	ENGINE NO. 165. Shaking grates.	ENGINE NO. 152. Water grates, with cast-iron filling pieces.
Pounds coal per car-mile	5.56	5.38
" water per pound coal	4.56	4.43
Average number of cars	26.	27.
Maximum boiler pressure	157.	155.
Minimum boiler pressure	120.	115.
Average boiler pressure	145.9	142.8
Coal per square foot of grate per hour	26.2	26.3

31. *First cost* is stated by the New York, Ontario & Western to be in favor of the shaking grates, the material alone costing about four-sevenths more for water tube grates of Plate 6 than for shaking grates.

The *durability* of shakers is greatly in evidence, though less care is needed to secure it. With proper locks, the fireman is automatically careful, and very much less care is needed in the roundhouse in the shape of weekly inspections and washing out of tubes.

32. *Repairs* can be executed with much greater speed and much less expense. A burned or broken shaker can be easily replaced: most easily when transverse; while in the longitudinal type the wrought-iron pivot bar, if the grate ever chances to be very badly burned and unusually warped, may be pulled out if need be by a chain attached to another locomotive.

33. *Longitudinal slope* is generally used, though by some thought needless. It varies from ½ inch to 1½ inches in 12 inches, usually having less slope in fire boxes

over drivers than in the narrow. Plate 13 shows a very great slope, some 2¼ inches in 12 inches. It is said, by the road using it, to give good results in lack of binding and in saving flues, and it is not improved by dropping back end. Occasionally there is found in this country even greater slopes for bituminous, a six-wheel switcher on a New York State road having some 5 inches in 12 inches of the horizontal.

34. The width of shakers averages 10 or 11 inches for transverse grates to 9 inches for longitudinal grates.

The width of fingers is never less than ½ inch, and commonly ¾ inch; ¾-inch fingers are used with $1\frac{1}{16}$-inch openings on the latest Pennsylvania passenger. Longitudinal grates for lump coal on the Lehigh Valley have finger and opening, both one inch. Plates 12 and 13 show rather unusual openings in the grates.

The fingers should be of considerable depth and their ends rounded to avoid forming a hook under which lumps of coal or clinkers could lodge when shaking and prevent the return of the grates to their normal position.

The cross ribs should be thin, but very deep at the center. Plate 8 is an excellent design.

TRANSVERSE SHAKING GRATES.

35. These are shown on Plates 8 to 13 for fire boxes between drivers, 14 for fire boxes over drivers, and 16 with tubes over drivers.

Shaking by sections is recommended by the Schenectady Locomotive Works: "a surface 40 inches wide by 11 feet long being divided into three parts, giving greater ease in handling and permitting the different portions of the fire to be cleaned separately." The Pennsylvania pursues this plan upon its latest engines, though the earlier Plate 11 shows only two sections. The Erie and Ontario state that a section of twenty square feet is the maximum that one man can handle to advantage, twelve to fifteen square feet being much more advisable. An examination of the plates will show how the sections are arranged and connected to the fireman's levers.

36. *The side bearers*, which carry the grate trunnions, are supported on the Erie by ties running across fire box and bolted to under side of mud ring, as on Plate 8. In this, no strip is used across front end of grate to connect side bearers.

The side view of Plate 10 shows the ties bolted to inside fire-box sheet at mud ring. The side-bearer cross support is seen to have a thin upper edge projecting up next the fire between the shakers.

Plate 11, Fig. 1, shows Pennsylvania side-bearer support resting on the upper sloping flange of ash pan. Fig. 2 shows the latest design, in which the side bearer forms the upper flange of ash pan and is itself bolted to under side of mud ring and by studs to inside sheet of fire box. There are also six safety guards bolted to frames so as to slide with expansion and contraction of the boiler.

Plate 12 is noticeable for having bosses projecting from the side bearers, upon which the grates rest; also for the support of the side bearers as seen at A and B.

Plate 14 shows Ontario side bearers supported by the end bars which are borne by studs into fire-box sheet. The center is supported by a cross tie, also bolted to sheet.

Plate 7 shows Delaware, Lackawanna & Western side bearers as merely six detached brackets, four of which are bolted up to under side of mud ring (Fig. 1). Fig. 2 shows side bearers entirely clear of boiler sheets.

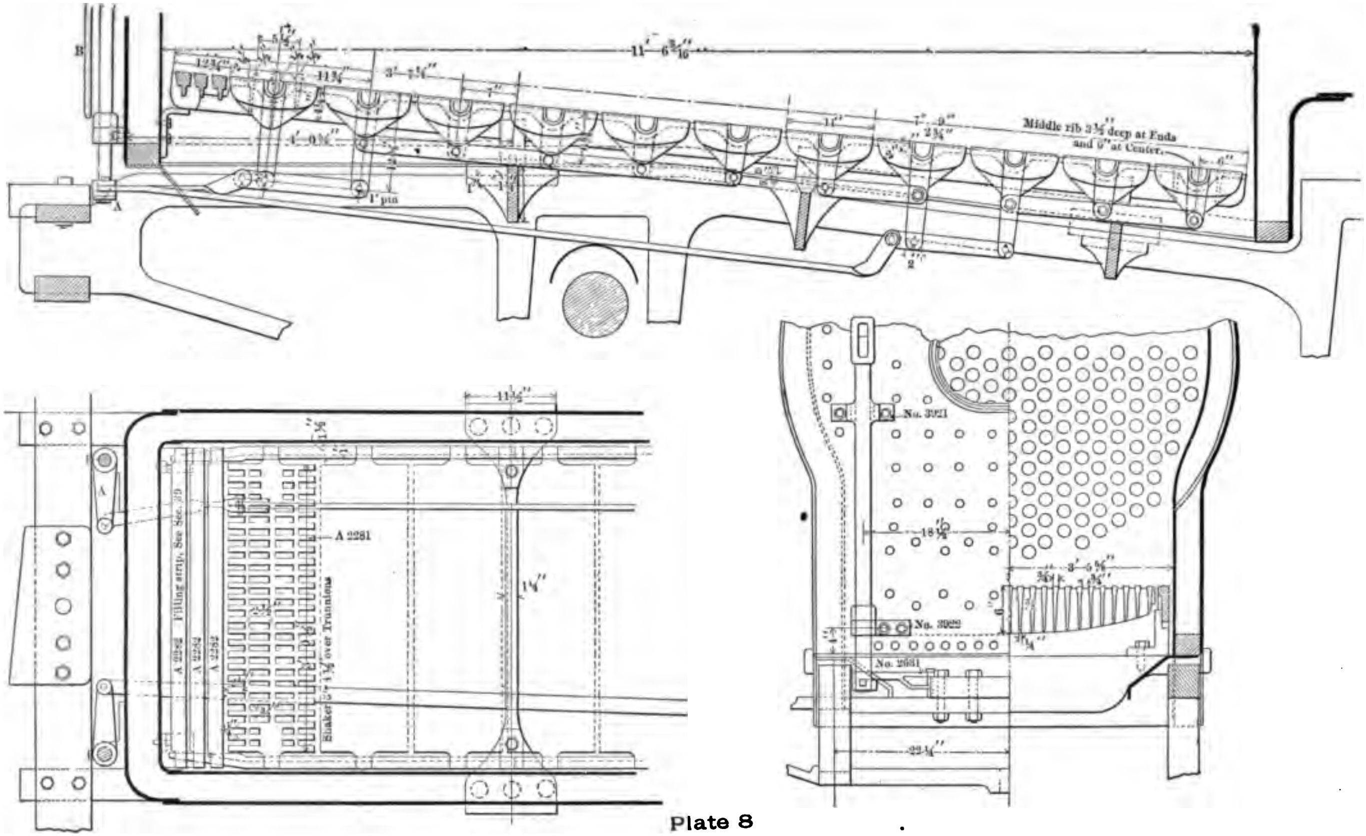


Plate 8

Standard Transverse Shaking Grates

Erie Railway Susquehanna Pa. 1893.

See Sections 17, 36

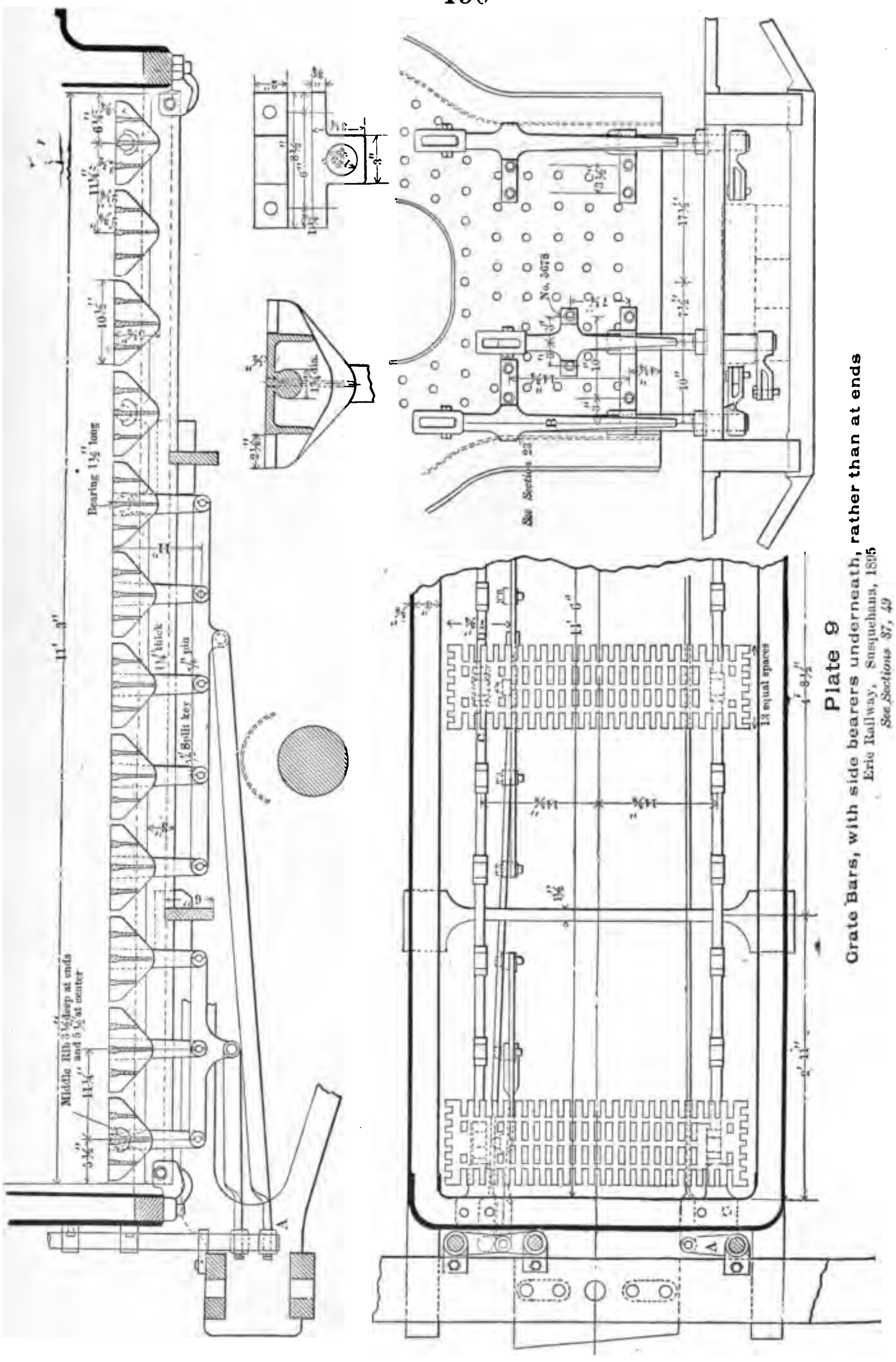


Plate 9

Grate Bars, with side bearers underneath, rather than at ends

Erie Railway, Susquehanna, 1895

See Sections 37, 49

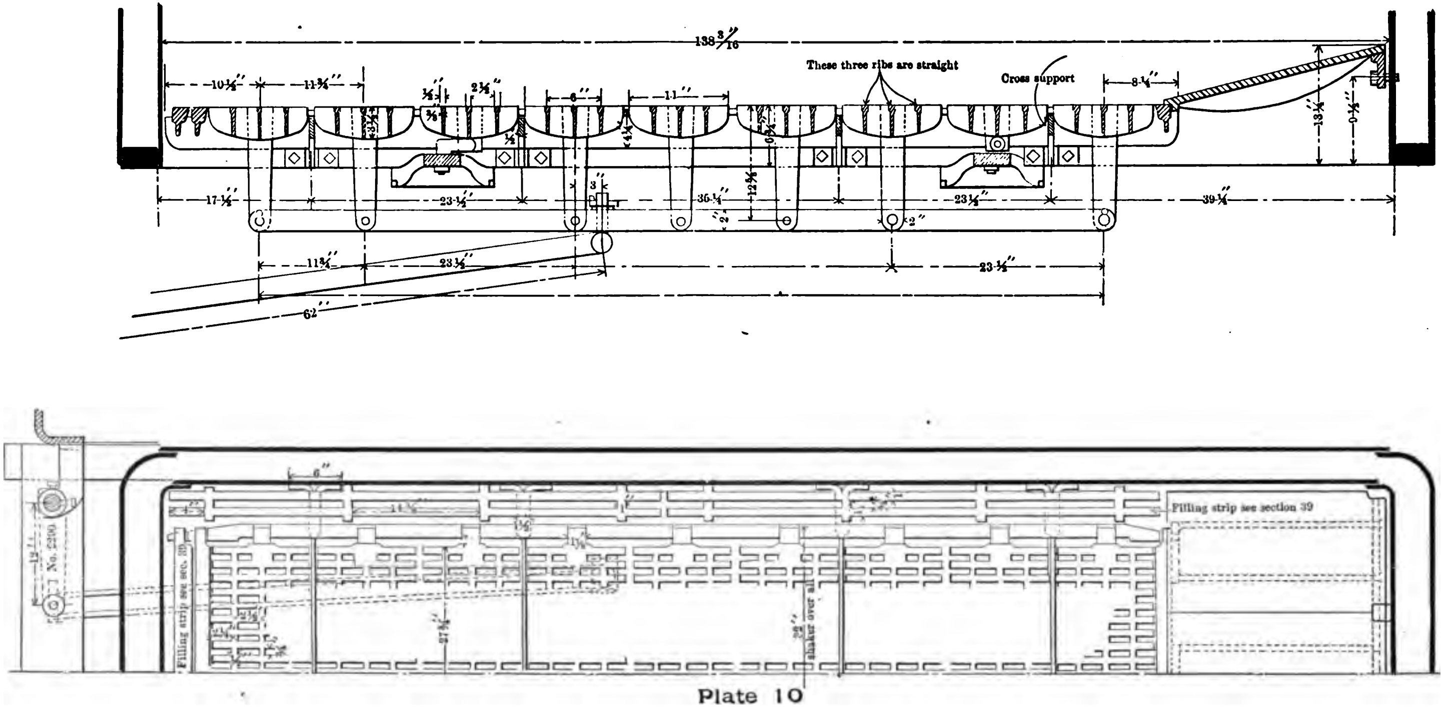


Plate 10

Grate with cast iron side strips and inclined dead plate

Erie Railway Susquehanna Pa., 1889.

See Sections 36, 39

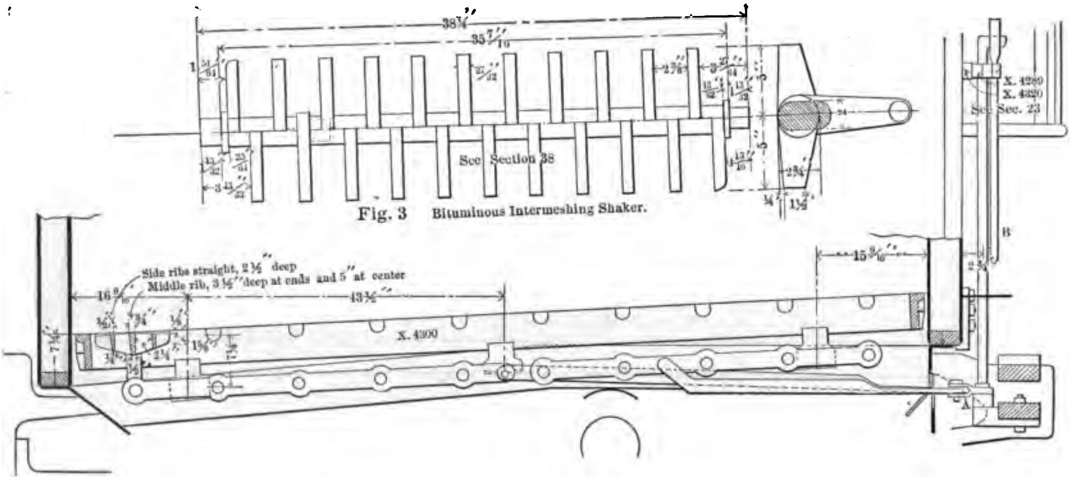
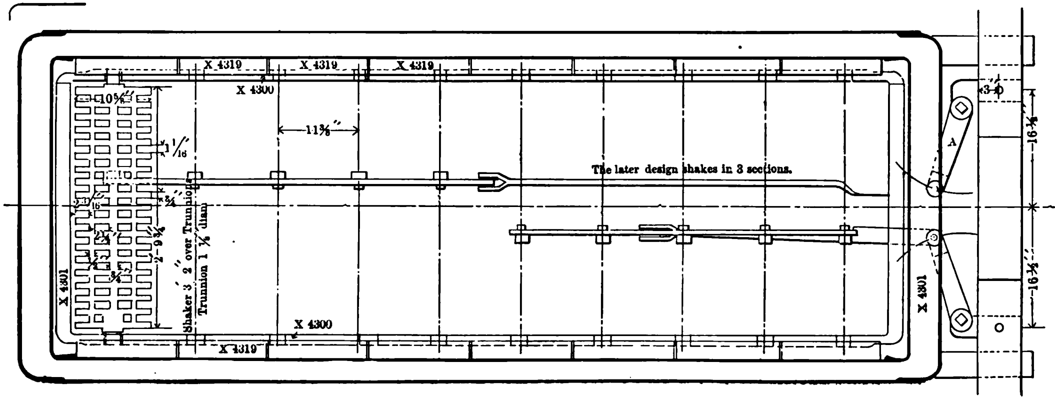


Fig. 3 Bituminous Intermeshing Shaker.



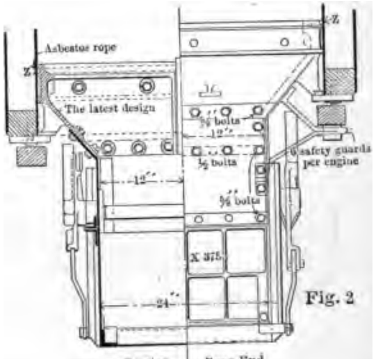


Fig. 2

Section Rear End.

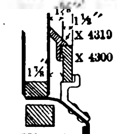
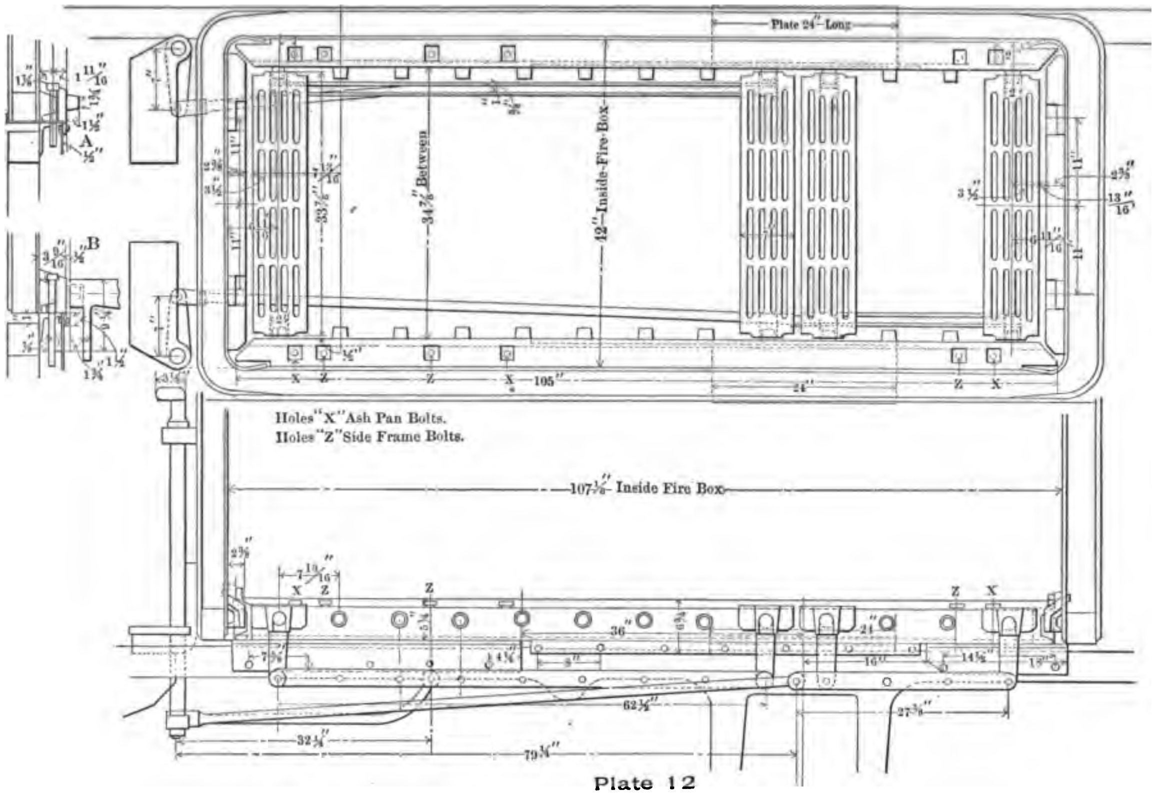


Fig. 1

Plate 11.
Shaking Grate for 8 wheel Express Locomotives.

Pennsylvania Railroad 1894

See Section 36. 37.



Holes "X" Ash Pan Bolts.
Holes "Z" Side Frame Bolts.

Plate 12

Transverse grate, with axial openings.

Schenectady Locomotive Works 1896.

See Section 36

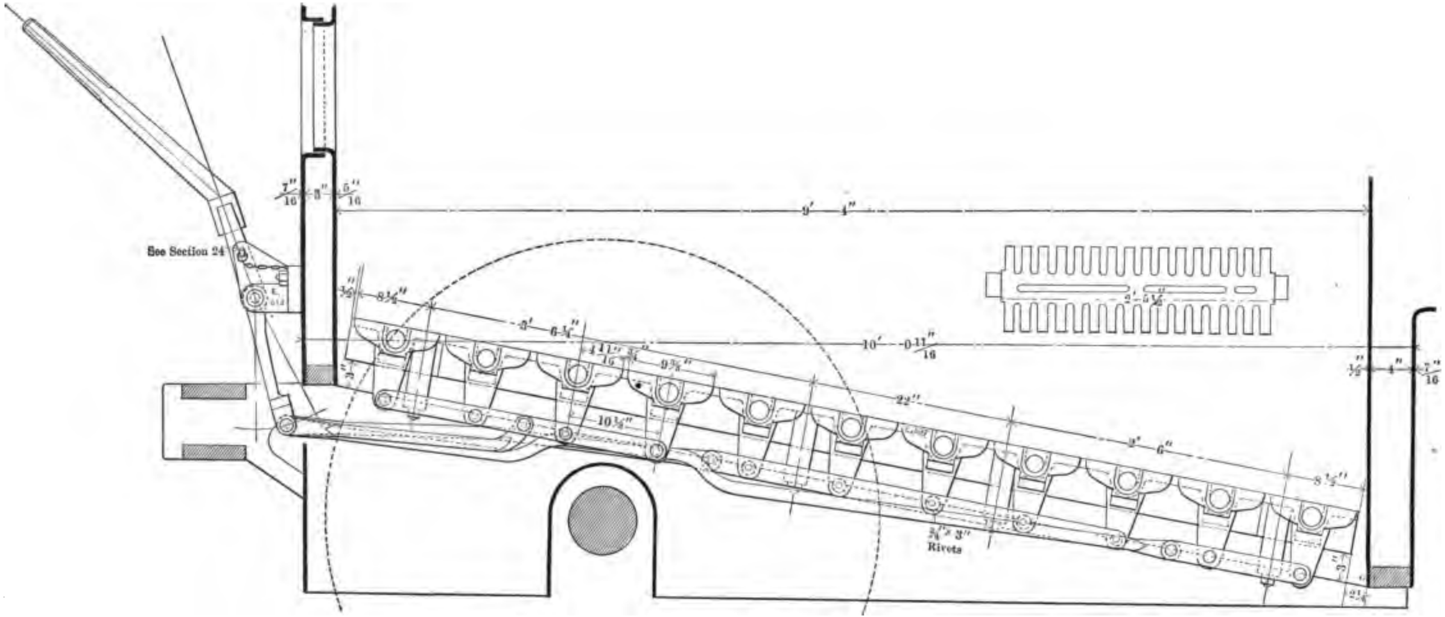


Plate 13

Transverse shaking grates with great slope.
New York Ontario and Western Railroad. Middletown, N. Y. 1895.
See Section 33

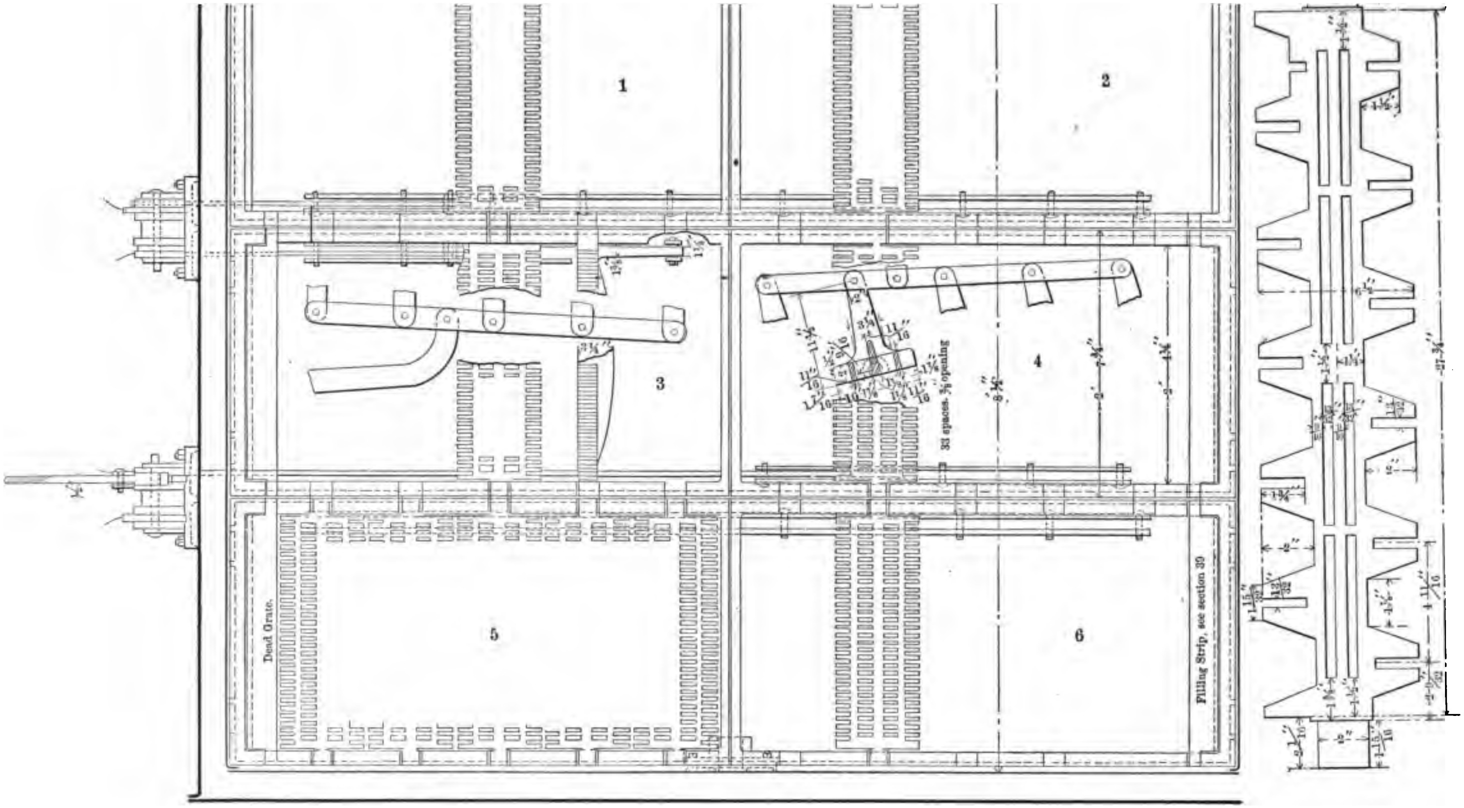


Plate 14

Grate for fire-box over drivers used for pea or culm.
N. Y., Ontario and Western Ry. Middletown, N. Y. 1894.
See Sections 36, 40.

Warning needs to be given not to have too many side-bearer supports attached under mud ring, lest there be too great difficulty in attaching the ash pan tightly enough to prevent fine ashes sifting out into the machinery.

37. *Corrosion of side sheets*, due to ashes behind side bearers, has caused some trouble. The Erie finds that when bearing bars have been located very close to the side sheets, ashes soon fill the space between them and cause rapid corrosion of the sheets. In all fire boxes, it is highly desirable to have the bearing bars away from the side sheets. They should stand off at least ¾ inch from the side sheet at the upper edge, tapering to one inch clearance at the lower, and so placed that the lower edge of the bearer is above the mud-ring rivets, which latter should, when practicable, all be driven or riveted on the inside of the fire box, so as to form as small heads as possible. When the bearing bars are supported by brackets, the latter should be so made as to render the lodgment of ashes impossible by rounding their upper edges. Very little difficulty will be experienced with the lodgment of ashes when bearers are applied in the manner above specified. The above is Erie experience.

The Erie design of Plate 9 should happily overcome all difficulty, since the side bearers are removed four inches from side of sheet and the entire width of fire box is shaken.

The Pennsylvania attempted to overcome the difficulty of lodgment of ashes between side bearer and sheet by dropping in cast-iron filling pieces, as shown by X 4319 in Fig. 1, Plate 11. Its latest construction is Fig. 2, Plate 11, by which is placed asbestos rope at Z. It adds: "We feel satisfied in saying that there is less corrosion where the shaking grates are used." The Lehigh Valley has "not had much trouble," but nearly all the Lehigh Valley shakers are longitudinal, as per Plate 15. The Ontario says that no arrangement is known there that will overcome this corrosion — shakers and tubes are about alike. No trouble on the Delaware, Lackawanna & Western, because there is no room (see Plate 7) for ashes to lodge.

38. *Intermeshing* of the fingers of one grate between the fingers of adjacent grates is not common for anthracite. Plate 11, Fig. 3, is standard for bituminous on the Pennsylvania in the engines of Plate 11. Its fingers overlap four inches on each side. When that road adopted shaking grates for anthracite, the intermeshing was passed by and the grate of Plate 11 designed and now used for anthracite by preference. Fig. 1, Plate 14, is an intermeshing anthracite grate in use on the Ontario.

39. "Perforated *dead plates*," says the Erie, "should only be used to fill out space that cannot well be covered with the shaking grates themselves." Filling strips are shown at fire-box ends on Plates 8, 10 and 14, and they may be thus used in order that special widths of grates need not be carried in stock, but one casting answer for many different widths of fire boxes. This is a very important item on railroads having a great variety of locomotives, since the stock of the general storehouse represents so much capital locked up from interest-bearing. The same end is gained by varying the number of tubes between longitudinal shakers.

Plate 10 shows an inclined dead plate at front end as used in 1889.

A *drop plate* is further recommended by the Erie to be employed at front end when transverse shakers are used, so as to clean the fire more readily and at the same time avoid loss of fuel as far as possible. On the other hand, the Pennsylvania considers it "unwise to sacrifice that amount of grate area; when it is desired to drop the fire, the grates can be tilted sufficiently." The Pennsylvania has no fire boxes over drivers.

40. Plate 14, *transverse shakers over drivers*, of the Ontario, is almost identical with the practice of the Erie also, though the latter has six shaking levers and fills in front and back of grate with four long, narrow filling bars. The lever is similar in general design to that on Plate 13. The side view, not shown, is precisely the same as on Plate 16. The Ontario states that "all parts can be loosened and taken out of the fire door."

An early non-intermeshing *bituminous* cast-iron shaking grate is not illustrated. It was the "Passmore" grate of the Pennsylvania, and had the peculiarity that the shaking portion of grate was made up of small pieces with shanks fitting into holes in the rocking axis. When these pieces were burned they could be removed and new ones inserted without disturbing the entire shaker and its attachments. This arrangement has not, however, been kept in service.

LONGITUDINAL SHAKERS.

41. These, in combination with water tubes, are illustrated in Plate 15 as they were adopted for the eight-wheel and ten-wheel passenger and fast freight locomotives designed by the Lehigh Valley and built in 1895. When all-shakers are used there is no difference made in the design; the grates are simply brought almost as close together as they would be to the tube. The Lehigh Valley is the only road reporting experience with longitudinal shakers, and its experience has been long and satisfactory. The all-shakers are preferred to shakers and tubes, except as regards weight, for which see Section 21. There should never be more than two tubes together, since more will be apt to give a line of dirty fire not stirred up by the shakers.

42. *The advantages* of the longitudinal grate over the transverse are as follows: no side bearers to give weight and corrosion; no intricate or short-lived side-bearer supports; fewer and more simple parts, including lever connection; can be lightened by tubes in narrow fire boxes; standard castings rather more profitably adapted for all widths of fire boxes by using one or two intervening tubes, than by the filling pieces used for the same purpose with transverse shakers; easier to locate cross support to avoid driver.

The disadvantages are: cannot shake front and back parts of fire separately; more difficult to renew, as per Section 32; long sections warp sidewise worse; longer sections must be stronger and heavier, especially in the bellying rib; requires more locks; standard castings not so easily adapted to all lengths of fire boxes.

43. The pivot bar S 22 of Plate 15 is 1¾ inches diameter, the hole cored through grate being 2 inches except at the ends, where it fits the bar closely and is keyed to it. It will be observed that a strip of grate intersecting the entire length of the fire box is shaken, there being six such strips in the case of Plate 15, having fire box over drivers. The strips are never connected so as to be shaken more than one at a time. The methods for holding the bars level, on back head, and of tilting the side grates only toward middle, were noted in Section 25. At A is shown thimble reinforced inside for wear. Fig. 1 shows an end view of a like grate ¾ inch wider, with 1 inch fingers and spaces. The end of finger should always be curved from the center of rotation to avoid clogging between adjacent grate.

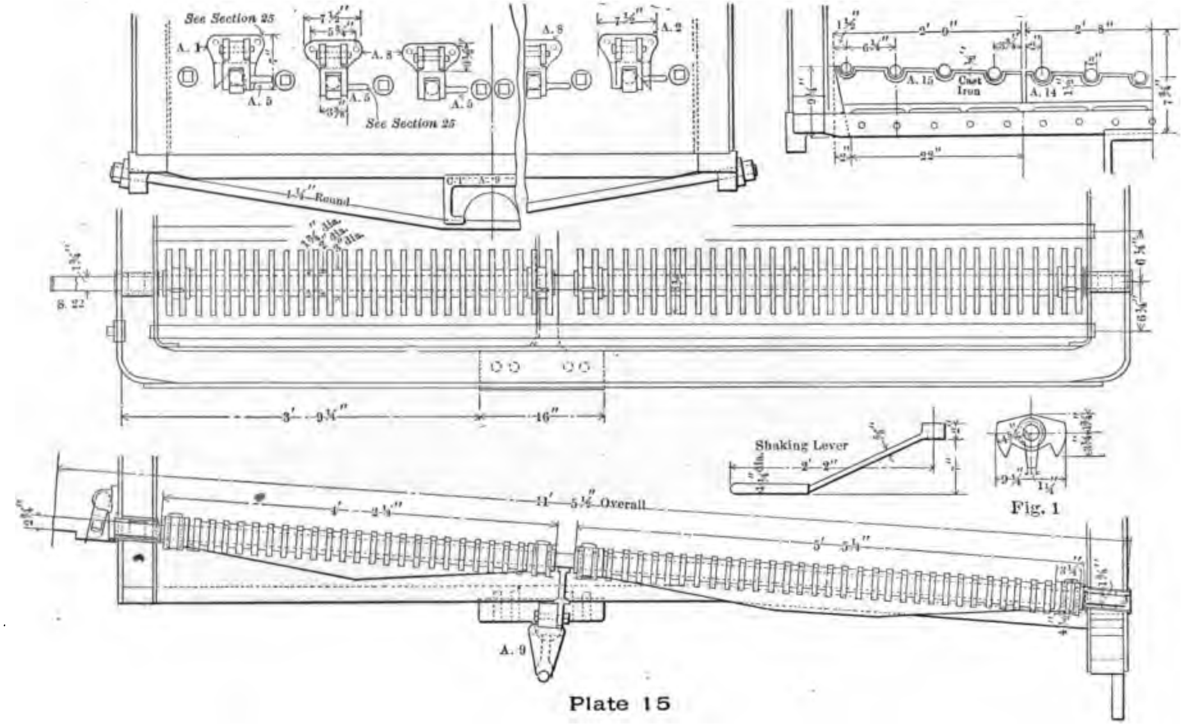


Plate 15

Longitudinal Shakers with Water Tubes.

Lehigh Valley Railroad. Easton, 1895

See Sections 21, 41, 42, 43

The cross brace is rigidly trussed, and by its being twisted enables the grate support casting, A 15, to be used for both sides of fire box. The casting is the part that wears out, not the cross brace. The sides of the grate are raised to clear drivers. A slope of about an inch per foot is necessary because of the tubes, and their back ends should be free to slip.

SHAKERS, TUBES AND FILLING PIECES.

44. These are shown on Plate 16 for fire box over drivers on the New York, Ontario & Western Railway. The use of tubes and filling pieces, next the side sheets, whether with longitudinal shakers or with transverse shakers as here, is probably the best method for overcoming the difficulty of the shallowness of the ash pan at this point and preventing the burning and the lifting of the grates out of position. It is an arrangement along the sides like that which in Plates 4, 5 and 6 was used over the entire grate. As compared with all transverse shakers upon Plate 14, of the same road, the Ontario says: "These grates and water tubes are a great improvement over the shaking grates, overcome the defects, and in my opinion this is the most satisfactory arrangement arrived at to date. The most successful engines we have, eight-wheel standard passenger engines burning pea or refuse lump upon sixty-three square feet of grate, are using this arrangement. It enables us to clean the fire quickly and overcome the objections of cinders and ashes getting between the bottom of grate and ash pan, on these wide fire boxes." The Ontario has fire boxes over the drivers, burning fine coal, equipped with all-shakers as above; with shakers, tubes and filling pieces, as above in Section 40 and Plate 14; and with "all tubes and filling pieces" like Plates 4, 5 and 6.

GENERAL CONSIDERATIONS.

45. That grates should be *level transversely* is asserted by the Ontario, Lehigh Valley, and Delaware & Hudson; though the two latter would make an exception where it is necessary to clear over drivers. The Delaware, Lackawanna & Western gains two inches for drivers in the latter way. The Delaware, Lackawanna & Western and Erie, in narrow fire boxes with water tubes, prefer the staggered arrangement of Plate 1 and Section 11.

The Pennsylvania replies: "It would seem to be a good idea, if it were feasible, to slope water grates from the middle to the sides of fire box, as the fire seems to burn up very much faster along the sides than in the middle, and consequently the thickness of the fire should be a little heavier. With water grates there is an air space of about one-half inch between grate and side sheet which allows the air to be driven up along the side sheet, consequently increasing the rate of combustion at that point. Our experience seems to show us that a greater portion of the firing is done along the sides of the fire box."

46. *Combustion chambers* for fire boxes over drivers are not liked. While it appears that the one engine on the Delaware & Hudson thus equipped is a better steamer than others like it in other respects but without the combustion chamber, yet the road is not in favor of the design. A brick wall is required. The cinders fill the combustion chamber and cover two to three rows of tubes.

The Delaware, Lackawanna & Western replies: "We use same type of grate in fire boxes having combustion chamber as those having none. The only difference

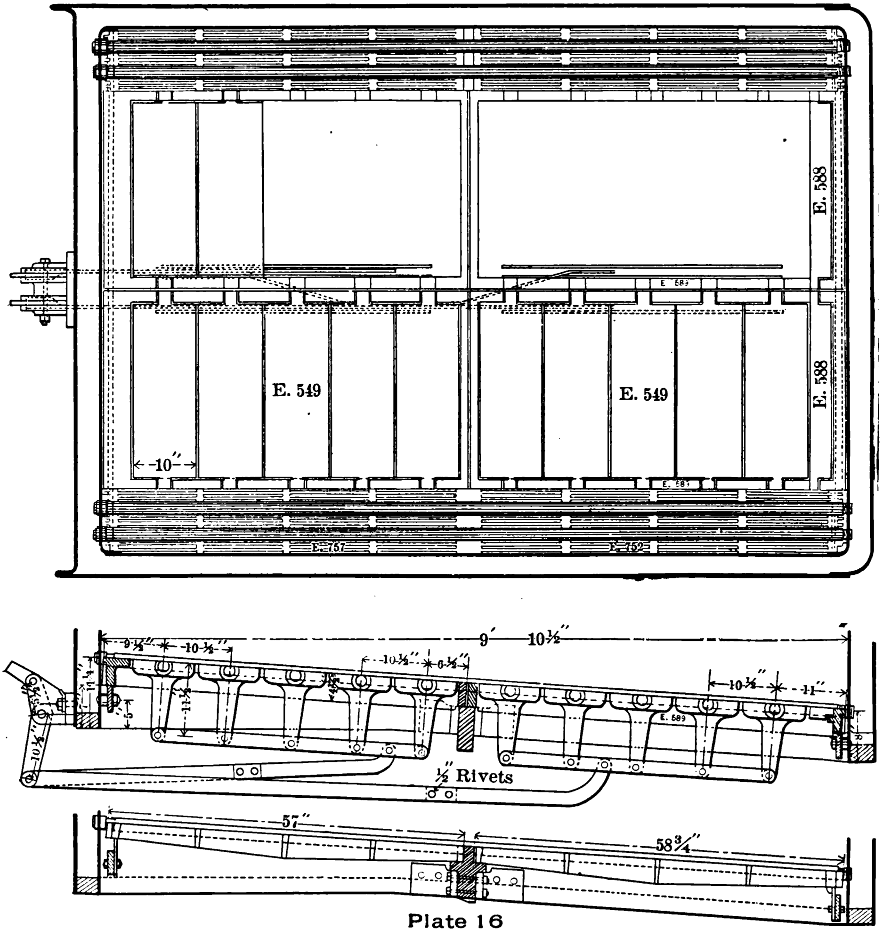


Plate 16

Transverse shaking grates, with tubes and filling pieces at the side. Fire box over drivers.

New York, Ontario and Western Railway. Middletown N. Y. Oct. 1896.

See Section 44

is that with a boiler having a combustion chamber it is possible to keep the boiler lower than a boiler having none. We prefer boilers having no combustion chamber, for the reason that on boilers having chamber the fire has to be knocked out about every six days in order to permit space between brick wall and flue sheet to be cleaned, also to clean out the flues. We have recently altered several boilers, leaving the chamber out. We find that the engines steam just as well without them. The loss of heating surface in cutting out a combustion chamber is compensated by the additional length of flues." The Philadelphia & Reading finds the Wooten boiler satisfactory for burning low-grade buckwheat.

47. *Openings in grates*, or between tubes, of course, vary with size of coal used, and even then differ on different roads, as the following table shows:

	Buckwheat.	Pea.	Nut.	Egg.	Lump.
Philadelphia & Reading	½ use for	d even egg.	11/16	⅞	
Erie	....	⅜	used also any size	for coal.	¾
Ontario	⅜ to 7/16	....	....	....	¾ to 1
Delaware, Lackawanna & Western	5/16	....	....	......	1 to 1⅜ (tubes and bars).
Delaware & Hudson	......	5/16	....	....	1⅛ (between tubes).
Lehigh Valley...	....	⅜	....	....	1
Pennsylvania....	....	....	....	......	1 1/16 (shaker). 1¼ (between tubes). 1⅜ (between tube and bar).

48. *The size of coal* does not by its variation require a variation in type of grate as between tubes and shakers — simply in size of openings. The tendency with the anthracite-mining roads is to use the more slaty lump and the buckwheat coals, in both cases pointing to the still further adoption of the fire box over drivers. A perceptible difference is seen in the more common connection of lump to narrow fire boxes, and fine coal to the wide. The Delaware, Lackawanna & Western is altering its wide passenger grates from pea to buckwheat burners. The Pennsylvania does not have a single boiler over drivers. It states: "The anthracite coal used on our line is composed of the larger size lumps separated at the mines before the coal passes to the crushers. Some of these lumps are delivered to our locomotive tenders in large sizes, weighing probably as much as 60 pounds, but we get with this coal a great amount of the smaller sizes which are broken up, due to handling. The most suitable size for our types of locomotives would be lumps weighing probably 6 to 10 pounds. Anthracite coal under forced draft soon becomes disintegrated, but the particles seem to stick quite closely together, and with shaking grates, provided with openings about ¾ inch by 2¼ inches, as Plate 11, there does not seem to be much trouble from falling through."

49. Formation of *holes next to side sheets*, and the consequent *blow-pipe action* upon the sheets, has not been noticed on the Ontario. Until recently the Pennsylva-

nia used the filling pieces shown by Fig. 1, Plate 11, but now the design of Fig. 2, Plate 11, with asbestos rope in the groove at Z. These were intended also to overcome lodgment of ashes and consequent corrosion, and have been successful. The Delaware, Lackawanna & Western replies: "In wide fire boxes over drivers we put in solid grates between side sheet and nearest water tube, as shown on Plate 6 in cross section of fire box, and allow just as little air as possible to pass between sheet and water tube on the sides. In the front and back of fire box we make the cast grates solid for about six inches from sheets. This protects the sheets, and since we have ample grate the loss in area is not noticeable in the steaming of the engine. On front and back of fire box, the grates, where we make them solid for six inches from sheets, are solid only for the width of fire door in the back and width of flue sheet in front, as water is not solid at these points." The Pennsylvania believes that this would give a greater trouble, namely, corrosion of side sheets.

Plate 9 of the Erie is an attempt to remedy both this difficulty and corrosion. "By thus placing the bearing bars below the grates, the distance between the end of the grate and the side sheet may be made equal to the width of opening between the grate fingers, though recent experience indicates half this, or ⅜ inch; which construction, together with a properly adjusted diaphragm plate and careful firing, will, it is believed, entirely prevent the formation of holes in the bed of the fuel next to the fire-box sheets, and the blow-pipe action on the latter." In general, holes in the fire bed indicate improper adjustment of the diaphragm plate and draft pipe, as stated by the Delaware & Hudson and Pennsylvania. Sometimes it appears desirable to have the diaphragm plate higher in the center, so that it will make a harder draft on center of fire.

50. *Depth of fire.*— The Erie reports that "for lump anthracite the shaking-grate surface between drivers should be at least from sixteen to eighteen inches below the fire door, and it is desirable to have a downward slope toward the front of about one inch per foot. An insufficient depth of fire box at the flue sheet is detrimental to the flues, both on account of their proximity to the fire and the liability of their ends being struck by lumps of coal during the process of firing. With anthracite coal the depth of the fire carried is dependent upon the size of the lumps used; if the latter are large, a thick fire is required, as even with a deep fire there is a constant tendency to the formation of air passages between large lumps of hard coal. With broken anthracite a thin fire is required."

The Delaware, Lackawana & Western replies that with lump coal in fire boxes between drivers the depth at first can be no thinner than seven or eight inches, and this gradually deepens during the run. It found that increasing the slope of these water tube grates from ¾ and ⅞ inch to 1 inch in 12 inches gave a better distributed draft.

For fire boxes over drivers using fine coal on tubes and filling pieces the depth of fuel is seen from the following replies:

Delaware, Lackawanna & Western — "It is very light at first, about two inches, which of course increases. By judicious light firing the fire cleans itself, the coals being kept dancing uniformly in all parts of the fire."

New York, Ontario & Western — "Impossible to get over eight or ten inches."

Delaware & Hudson — "We carry about twelve inches."

51. The *rate of combustion* per square foot of grate averages less for anthracite than for bituminous, appearing much like the English rate for bituminous. The water evaporation per pound of even the best lump anthracite, when least forced, falls below fair bituminous performance.

The Pennsylvania Railway sends results of tests, Table I, made upon the New York Division with the latest design of eight-wheel passenger engine, burning lump anthracite upon 33.24 square feet of shaking grate on top of frames, as per Plate II:

TABLE I.

	Lbs. coal per square foot grate per hour.	Corresponding evaporation, lbs. of water per 1 lb. coal.
Maximum	84.8	5.82
Minimum	54.8	6.38
Average	67.5	6.08
Average number of cars	5.88	
Average speed, miles per hour	45.34	
Average coal per car-mile, pounds	8.42	

For efficiency, this table should be compared with Tests 1 and 2, Section 30, made upon the New York, Ontario & Western.

For *comparisons* of the rate of combustion — with regard to the service, style of fire box, style of grate, and size of fuel, on different roads — Table II is given. For figures under most like conditions it should be read horizontally, though on any one road it may be read vertically if it is desired to know how consumption varies with different coal and grate in the same service.

The data for the Delaware, Lackawanna & Western were taken from performance sheets of total coal per run, speed not given. The coal per locomotive mile was, for lump, 100 pounds maximum and 63 pounds minimum; for fine coal, 100 maximum and 47 minimum. The coal was divided into pounds per square foot grate per mile by the following dimensions given for grate area:

	Freight.	Passenger.
Between frames	24	29
On top of frames	32	36
Over drivers	76	80

Pounds per square foot grate *per hour* were computed for assumed speeds of 15 miles per hour for freight and 30 for passenger. The first two columns are therefore of chief value for reading vertically. It is probable that the 20 pounds and 9 pounds result from too low an assumed speed.

TABLE II.—POUNDS OF ANTHRACITE PER SQUARE FOOT GRATE PER HOUR.

			Delaware, Lackawanna & Western.		Delaware & Hudson.			New York, Ontario & Western.				Pennsylvania.
			Frt.	Pass.	Frt.	Pass.	?	Pass.	?	Frt. Test.	Pass. Test.	Pass. Test.
			Computed for 15 m. p. h.	30 m. p. h.						14.5 m. p. h.	32.9 m. p. h.	45 m. p. h.
Coal, Lump. Fire Box, between Frames.	Freight	max.	63 w	......	......	......	45 w	......	......	......	......	......
		min.	39 w	......	......	......	32 w	......	......	......	......	......
	Passenger	max.	......	103 ws	......	......	......	75 s	......	......	Ave. 77 s 81 w	......
		min.	......	65 ws	......	......	......	......	......	......		......
Coal, Lump. Fire Box, on top of Frames	Freight	max.	47 w	......	......	......	......	......	......	......	......	......
		min.	30 w	......	......	......	......	......	......	......	......	......
	Passenger	max.	......	83 ws	......	40 w	......	......	......	......	......	..85 s Ave. 68 s ...55 s
		min.	....	53 ws	......	25 w	......	......	......	......	......	
Coal, Fine. Fire Box, over Drivers.	Freight	max.	20 wf	......	34 wf	......	......	......	......	Ave. 26.2 s 26.3 wf	......	......
		min.	9 wf	......	21 wf	......	......	......	......		......	......
	Passenger	max.	......	38 wf	......	......	......	......	46	......	......	......
		min.	......	18 wf	......	......	......	......	......	......	......	......

w = water grates only.
s = shaking grates only.
wf = water tubes with filling pieces.
ws = water tubes with shaker fingers.

52. *Anthracite vs. Bituminous.*

The following reply gives for comparison the averages of thirty Erie engines using hard and soft coal on entirely shaking grates of the same type:

Hard coal:	*Freight.*	*Passenger.*
Average pounds per mile	122	112
Average cars per draft	17.3	7
Soft coal:		
Average pounds per mile	120	110
Average cars per draft	18.15	7

Hard coal, per freight car mile	7.05 lbs.
Soft coal, " " "	6.06 "
Hard coal, per passenger car mile	16 "
Soft coal " " "	15.07 "

In conclusion it should be added that the kindness of those who have so cordially and fully answered inquiries has been appreciated, and special thanks are due to Mr. A. E. Mitchell, S. M. P., and Mr. G. H. Goodell, M.E., of the Erie Railway, for valuable assistance in the preparation of this report. The committee is placed under great obligation to the New York, Ontario & Western Railway for the extensive competitive tests of grates.

Respectfully submitted,

H. WADE HIBBARD,
GEORGE W. WEST,
DAVID BROWN,
EDWARD L. COSTER,
Committee.

UNIVERSITY OF MINNESOTA,
MINNEAPOLIS, May 7, 1897.

THE CHAIRMAN: You have heard the report on Locomotive Grates as presented in abstract by Professor Hibbard. What is your pleasure?

On motion of Mr. Henderson, the report was received and opened for discussion.

MR. GAINES: On the Lehigh Valley we prefer the longitudinal shaking grate with wrought-iron bearing bar of same general design as shown on Plate 15, as it is better adapted to the many widths of fire boxes on our road. This style of grate seldom if ever breaks, and is easily removed or applied. It does away with bearing bars along the side sheets and all their attendant evils. On engines having the wide fire box over the wheels we only use one water bar between any pair of grates. On all other engines we use no water bars at all. We object to one or more water bars along the side of fire box, as on runs where there is no opportunity to clean the fires they make a dead place in the fires. We find that the bar locks are superfluous, and we are doing away with them. We have no trouble in keeping ashes off pockets of ash pans on engines having the wide box. Our standard grate has a ½-inch mesh and we have found that it works well with anthracite, lump soft coal, or a mixture of bituminous with either rice or buckwheat anthracite. With fire boxes more than ten feet long we approve of using a dead plate, as shown on Plate 10, when soft coal is used for reasons as given in report.

MR. GILLIS: I think probably all kinds of coal can be burned on those grates successfully. I can state from my own experience that I once had an engine with almost the same grates as has just been mentioned, although it was a grate across the fire box instead of a longitudinal grate, and we ran that train one way with hard coal and the other with soft coal every day without any difficulty at all. We also had this experience: we were burning soft coal entirely on all of our freight engines; there was a strike at the soft coal mines and we were forced to burn hard coal on every engine, and we burnt it successfully without any change of grates.

THE CHAIRMAN: Is there any further discussion on this subject?

On motion of Mr. Sinclair, the discussion was closed.

THE CHAIRMAN: The next subject is The Apprentice Boy.

Mr. Bradley presented the following:

REPORT OF THE COMMITTEE ON THE APPRENTICE BOY.

To the President and Members of the
American Railway Master Mechanics' Association:

A year ago your committee submitted a report on the apprentice boy, which will be found published on pages 282 to 290 of the Report of the Proceedings of the Association for 1896, in which your committee dwelt especially on the necessity of educating apprentices outside of the shops. Your committee in that report submitted the substance of correspondence with representatives of the University of Chicago and of Purdue University of La Fayette, Indiana. Your committee in that report did not attempt to submit any definite course of training for apprentices in the shops. In the course of the discussion which followed, the committee was continued, with especial instructions to recommend a course of shop training for apprentices in the various locomotive shops.

In confining itself, therefore, to this one specific department of the training of the apprentice, namely, the training inside the shops, your committee does not wish to be understood as considering that this is the only department in which care and pains are needed in the educating of apprentices. It hesitates even to say that the shop training is the most important part of their training. Apprentices must be made not only good mechanics but good citizens and good men. It is easy to say that a railway company is not responsible either for the citizenship or morality of its apprentices, but it is none the less impossible for the company to escape some share of such responsibility—at least of the moral kind. Moreover, on purely selfish grounds, it is to the interest of the railway company to see that the generation which is growing up is not only a generation of competent workmen but is also a generation of good citizens and good men. In confining itself in this report to the one subject of the shop training, your committee is obeying instructions, and for the larger field of outside training it begs again to refer to its report of last year, and to say distinctly that the report submitted herewith is only supplementary thereto, and that the field of shop training is only one department of the much greater field of the general education of the apprentice.

During the year your committee has conducted considerable investigation into the methods of different shops in the handling of their apprentices. It has obtained a large quantity of information, not only of the practice in this country, but of the practice in other countries. It has been largely helped by special efforts made by individual members of the Association, and it wishes especially to express its thanks to Mr. A. E. Mitchell, of the Erie Railroad, who, of his own initiative, compiled a large quantity of valuable data which he has placed at the disposal of your committee. It also desires to recognize the value of the report submitted to the Western Railway Club by a committee consisting of Messrs. C. H. Quereau, E. M. Herr, J. N. Barr, W. F. M. Goss and Storm Bull. This report was submitted to the April meeting of the above club, and was discussed at the meeting in May.

The first question to be considered is the length of term of service which an apprentice should serve. On this subject there are two diametrically opposed views held respectively by those who would place a rigid term of service consisting of a certain number of years or months on the one hand, and on the other hand by those who believe that the length of a term should be governed entirely by the merit and ability of the individual apprentice. From reports received from a large majority of the bigger shops in this country it is evident that the more general custom is the prescribing of a definite length of service. On the other hand, what the committee will call the merit system is in force in some shops whose practice we all recognize ought to command our highest respect; also the practice in other countries is in favor of the merit system as opposed to a rigid term of service, and in the discussion in the Western Railway Club, at the May meeting, already referred to, the majority of opinion was distinctly in favor of the merit system. If a rigid term of service is fixed the very great preponderance of practice in this country is in favor of a four-year term. There are one or two cases when a three-years' term is considered sufficient. The committee knows of one case where the term is fixed at five years. The four-year term, however, is almost universal. The committee believes that this term has been fixed as the result of long experience, and is in accordance with good judgment. In four years a boy ought to be able to acquire a thorough training, if he is a boy capable of ever becoming a mechanic. At the same time, four years is not too long a time to make the average boy spend on his training.

In drawing up any shop course, therefore, it should be based on an assumption that it is to cover a period of four years. Your committee, however, does not believe that it is fair to make all boys spend precisely the same time on the same work. Any course must be more or less elastic. Boys differ largely in capacity and in ambition. Moreover, the same boy will show greater aptitude for one part of his course than he will for another. While, therefore, we believe that four years should be regarded as the proper average time of service, and a course should be based on that length of time, there must be left discretion in whoever has charge of the apprentices either to permit a boy to go forward more quickly, or to hold one who is slow longer than the average at a particular class of work. Your committee, however, would not by any means have this to be interpreted as meaning that the discretion of the individual in charge is to be unlimited. With the brightest and most ambitious boy the committee would under no circumstances recommend the shortening of the term below three years. The committee does not believe that any boy ought to spend more than five years. A boy who requires five years of service to go through his course will certainly at an early stage of his training show such assurance of incapacity as to make it evident that he will never make a good mechanic. In such cases the boy should be promptly sent elsewhere. This power to discharge not only in cases of misbehavior, but for the reason stated, namely, of a general incapacity in the boy, must be reserved by the railway company, and ought to be unsparingly and conscientiously used both in the interests of the shop and of the boy himself.

With this understanding the committee submits herewith a schedule for machinist apprentices, which is in use on the Norfolk & Western Railroad, and which has been found very satisfactory:

Norfolk & Western Railroad Company.

Roanoke Shops.

Schedule for Machinist Apprentice.

Term commenced, ..., *18..*

Apprentice, ...

Term expired, ..., *18..*

Department.	Gang.	Apprenticeship Course.	Time.	
			Months to actually Serve.	Served.
Tool room...	....	General use of tools, names, etc., work on small planer, drilling machine, shaper and lathes, provide tools..............	6	
Erecting Shop.	No. 1.	Helping on general work	1	
	No. 2.	" " " "	1	
	No. 3.	" " " "	1	
Machine Shop	......	General instructions, milling machine, boring mill, horizontal machine, axle lathe, and helping in general	3	
		Boring, driving and truck brasses and quartering machine.......	2	
		Cylinder boring machine and planer	1	
	Rod..	Rod gang	3	
		Small lathe (alone)...........	2	
		Large slotter.................	1	
		Brass lathe	2	
		Small planer..................	1	
		Large and small planers	2	
		Driving wheel lathe...........	1	
		Large lathe (alone)	2	
		Motion work lathe.............	1	
		General vise work	3	
		Surface table..................	3	
Erecting Shop.	No. 1.	General work	5	
	No. 2.	" "	3	
	No. 3.	" "	4	
		Total months...............	48	

Your committee submits this as a basis for an adequate course of training in the machine shop, with the distinct understanding that it is to be qualified so far as the term of service to be spent in the different items, and also in the whole course, by the quality and capacity of the individual boys, under the discretion of whoever has them in charge.

The courses in the machine shops of most of the leading railways in the country correspond very closely with the above schedule. In few of them, however, is the time so closely divided as in the above. The committee is well aware that there must be frequent difficulty, perhaps impossibility, in complying in detail with such a close division of time, but subject to the qualifications already expressed we believe that this division of the Norfolk & Western schedule makes it better as a working basis than other schedules, which may be easier to comply with uniformly, which do not subdivide so rigidly.

Without making a definite recommendation on the subject the committee would call attention to one item inserted in the schedule submitted by the committee to the Western Railway Club above referred to, which recommended that in the course of the machinist apprentice a certain length of time should be given to acquiring experience, first, as blacksmith's, and, secondly, as boilermaker's helper, until a good idea of what is good blacksmith and boiler work has been gained. Your committee agrees with the suggestion herein contained, but would prefer to say that an apprentice should be given every possible opportunity to acquaint himself in a general way with other departments of the service — not only with other shops than his own, but with the drafting room and the storekeeper's office as well as with the transportation and railway departments. Many apprentices will get little or no benefit from contact with other departments outside of their immediate office work, but among them there will be some who are capable of taking in a wide horizon, and these should be given the opportunity — the opportunity to make good railroad men of themselves as well as good machinists. It is a subject which must be left largely to the judgment of the man in charge of the apprentices and to be adapted to particular cases.

Very little attention seems to have been given to the outlining of a systematic course in the blacksmith shop. In a very large number of shops no regular apprentices are taken. If young men go in as helpers and if they have influential friends among the mechanics they are pushed forward, and ultimately become mechanics in some haphazard way and without any regular rule governing their advance. Your committee believes that the course of training in the blacksmith shop should be just as carefully supervised and directed as that in any other department. As a basis for a course in this shop, subject to the same modifications as suggested in the course for the machine shop, the committee begs to submit the following:

BLACKSMITH SHOP COURSE.

1. To start the apprentice on a bolt machine for six months. Here he will learn the rudiments of heating iron; also the setting and adjusting of dies, and at the same time by observation will learn the names of the tools and their use in that portion of the shop.

2. The next six months in operating a steam hammer. In this position he has a good opportunity to note how the blacksmiths handle and form iron; at the same time require him to help at the fires in the immediate vicinity of the hammer.

3. The next six months should be as a helper on a small fire, with a man who is quick and handy with light work.

4. The next six months on a light fire without a helper where he will learn to handle the hand hammer.

5. For the next three months give him a light fire with a helper; the fire should be so located that he will be called on to assist in taking heats for the larger fires.

6. For the next six months on heavier work that does not require great skill.

7. For the next three months put him helping at the tool-dressing fire, and if the shop has two tool-dressing fires, the next three months on the second tool-dressing fire.

8. The next twelve months put him on a heavy fire with as much of a variety of work as can be arranged.

Much the same comments as to the general lack of system and rules apply in the case of the boiler shop. Again, the committee believes that the course should be definitely marked out and carefully supervised. As a basis for such a course, subject to the aforesaid qualifications, your committee submits the following:

BOILER SHOP COURSE.

1. The first three months heating light rivets.
2. The next three months helping on the heavy sheet-iron work, such as wheel covers, ash pans, etc.
3. Three months holding on rivets for tank work.
4. Three months holding on rivets for boiler work.
5. Six months riveting on patches, chipping and caulking on tank work.
6. Six months setting flues.
7. Six months patching and bracing boilers, chipping and caulking and general riveting.
8. Six months blacksmithing, to learn how to make and fit braces, to dress necessary tools and assist in fitting up his work.
9. The fourth year to lay out flange and do general boiler work.

Your committee would also recommend a general code of rules and regulations governing the relations of the company to all apprentices on the following lines:

1. For machinist apprentices, only those who are over sixteen years of age or less than twenty years of age.
2. For blacksmith apprentices, those who are over sixteen years of age and under twenty-four.
3. For boilermaker apprentices, those who are over sixteen years of age and under twenty-four.
4. All applicants for positions as apprentices must pass a creditable examination in all the studies taught in the public schools up to and including the eighth or grammar grade.
5. Each person so employed under the age of twenty-one years will be obliged to furnish the company with a minor's release (on form provided for this purpose) properly executed by his parent or guardian.
6. Apprentices are subject to the shop rules and the general rules and regulations of the company, and are liable to discipline or discharge for violation of these rules.
7. Apprentices will be paid for the actual number of hours worked each day; overtime to be paid for in accordance with the rules of the company; each day's work will be regarded as but one day in the apprenticeship record. (Apprentices will not be required to work overtime during the first three years of their term of service, except in special emergencies.)

8. Apprentices who are working with mechanics on piecework jobs will be paid their regular hourly rates; mechanics thus assisted by apprentices on piecework jobs will be paid only the proper proportion of the piecework rate.

9. Apprentices will be given the best opportunity to learn their trades and to become good mechanics.

10. Apprentices will be expected to comply with such regulations as to attendance at night schools or other classes as the company may see fit to prescribe.

Each road or shop, on account of its local conditions, may necessarily require special rules, but these general rules will serve in the majority of cases. The committee also submits a form of apprenticeship certificate which it believes each boy should be given when he has completed his course as apprentice, whether he continues in the service of the company or not.

While your committee is confining itself explicitly herein to suggestions for a course of shop training, and not for the general education and moral training of the boy, there should be a certain general education as part of the shop training. Your committee strongly recommends a careful record being kept of each apprentice by a system of merit and demerit marks, allowing a maximum number of marks for each week or month. The record should be carefully and regularly kept in a book, and while the essential thing to be considered in the marks is the application of the apprentice and the excellence of his work, his general behavior should be considered, and the maximum number of marks should not be attainable by an apprentice who in any way is not well behaved, quite apart from his actual work done. Your committee desires to insist strongly upon the desirability of such a record.

An important question, which perhaps does not bear directly upon the training of the apprentice as a mechanic, but may have a good deal to do with his shaping as a man, is the matter of payment. There should be a definite scale of payment per hour for the first year, and that scale should be increased yearly. This scale must perhaps necessarily vary in different parts of the country. Uniformity, however, all over the country is desirable. Your committee would suggest as an equitable scale of pay 50 cents a day for a ten-hour day, that is, 50 cents a day for the first year and an increase of 25 cents a day for each year thereafter. For an eight-hour day, 40 cents a day at the start and 20 cents increase yearly.

The company should not assume any obligations beyond the term of the apprenticeship. When the apprentice has served his course the company must be at liberty either to retain him in service and pay him journeyman's wages, according to his merit, or to let him go and seek work elsewhere.

The custom in regard to deduction of time for absences or on account of either vacations or sickness varies very largely in different shops of the country. Your committee does not think that deduction should be made for short absences. Certainly for not less than absence amounting to thirty days in the course of a year. Your committee does not think that the term of service ought to be extended to make up for time lost by a shortening of working hours in the shops, as time so lost is not lost by the fault of the apprentice, but by the company. All these details, however, it will be observed are necessarily covered by what the committee has said as to the modifications of the term of service in accordance with the merits and capacity of the boy. They must all be taken into consideration, when a definite course of four years is rigidly prescribed, but when, as the committee believes to be right, discretion is left with the man in charge to shorten that term to as little as three years and to prolong it if necessary to as long as five years, there is no necessity for special rules on the above points.

Your committee now comes to what it considers to be the most important point in the matter of the handling of apprentices. Your committee not only believes, but insists, that the charge of apprentices should be given to one particular and well qualified person, that person to be known as the Foreman of Apprentices, or by some such title. This practice is followed in other countries and is undoubtedly satisfactory. Your committee knows no other way of insuring the proper attention being given to apprentices without great waste of somebody's time. It is not necessary, except perhaps in the very largest shops, that the foreman of apprentices should give his entire time to this work; but your committee believes it to be most desirable that some one person should be distinctly charged with the care of the apprentices, and should be responsible for them, and that much pains should be taken in the selection of that man.

In the foregoing your committee has not considered the treatment of what may be called advanced apprentices or special apprentices. Apprentices who have already been through the technical school, of course, need different treatment to the regular apprentices. They are entitled to a larger rate of pay and require different treatment. The foreman of apprentices, however, should have charge of both classes alike, and the same foreman should have general control of the training and education of the apprentices outside of the shops. Your committee again respectfully refers to its report of last year on this subject.

The matter of the use of night schools, the question of whether these night schools should be established by the companies and controlled by them, or whether local schools can be utilized, are all important questions, the solution of which must vary in different localities. The establishment of permanent relations with one or more of the universities or other institutions of learning is a matter which your committee covered fully last year and to which it again calls attention.

As an appendix ("A") to this report your committee submits the recommendations on the subject of a course of study for evening schools submitted by the committee of the Western Railway Club, already referred to, and attached to this report your committee also submits as appendices "B" a form of certificate of apprenticeship, and "C" of release of minors.

In conclusion your committee wishes to say that it considers this general subject as important as any which the Master Mechanics' Association can discuss, and in which there is a work to be done ready to hand which is worthy of the greatest pains and best thought of this Association, a work which will not only reflect credit upon the Association, but which can be of permanent benefit to the railway service and to the country.

Your committee therefore recommends that a standing committee on this subject be appointed, and that that committee be empowered to enter into whatever correspondence may seem necessary with the managements of railway companies, with a view to securing the proper treatment of apprentices and the acquiescence of the managements in the appointment of a necessary foreman, and other matters, and that the committee also be given power in behalf of this Association to negotiate definitely with universities or institutions of learning for the establishment of courses in specified districts, as they may see fit, without waiting, if the committee deems right, for the approval of next year's convention. All of which is respectfully submitted.

(Signed) W. F. Bradley,
W. H. Harrison,
G. R. Joughins,
A. E. Manchester,
H. P. Robinson,
Committee.

APPENDIX "A."

First year: Plane geometry; geometrical drawing; elementary algebra.

Second year: Solid geometry; elementary descriptive geometry; algebra continued.

Third year: Plane trigonometry; physics; mechanical drawing.

Fourth year: Heat and electricity, or mechanism and kinematics; mechanical and free-hand drawing.

While it is likely that the precise character of the school work for any shop would depend somewhat on the taste and ability of those administering it, the committee would recommend that it be made the equivalent of that which is represented in the following detailed description, and suggests that the special apprentices might give valuable assistance:

Plane and Solid Geometry.— A study of the usual geometrical principles as set forth in any standard text-book, as, for example, Chauvenet's; the work to be constantly reinforced by original constructive work, such as may be suggested by the daily experience in the shop, or by Spencer's "Inventional Geometry."

Geometrical Drawing.— Instrumental work on the drawing board in the development and solution of geometrical problems. This work should keep pace with the study of geometry, which it should supplement in every possible way, and should be made to include a sufficient number of shop problems to disclose the breadth of the subject. Careful attention should be given to the manipulation of the drawing instruments, for this is a preparation for the work of succeeding years.

Algebra.— First year: Such an amount of elementary principles as are absolutely necessary in teaching geometry, including a discussion of the equation and of its meaning; addition, subtraction, multiplication, division, and linear equations.

Second year: Involution and evolution; factoring, with application of highest common factor and least common multiple; fractions and their algebraic operations; quadratic equations; systems of linear equations; ratio and proportion; theory of limits; logarithms; all principles to be enforced by practical problems, many of which should arise from conditions in the shop. Any of the many good school algebras may be used in this work.

Elements of Descriptive Geometry.— To be made up of problems in the development of surfaces and their intersections, the problems to come chiefly, if not wholly, from drawings of boilers or from boiler department. Some practice should also be given to isometric projection.

PLANE TRIGONOMETRY.— Half year: The measurement of angles, trigonometric functions, solution of triangles, trigonometrical tables and derivation of formulæ as found in any elementary text, to be enforced by as large a number of problems as practicable.

ELEMENTARY PHYSICS.— A study of the facts and laws of physics, chief attention being given to elementary mechanical principles, such as those included under the older term, "Natural Philosophy." A suitable text-book would be Avery's "School Physics," which contains a very clear, simple and accurate text, with numerous illustrative experiments to be performed by the student. The fullness of the directions for these exercises adds apparently, but not really, to the extensiveness of the treatment of the subject. If desired, Avery's shorter work, "The Elements of Natural Philosophy," may be used instead.

DRAWING.— Practice with instruments in drawing details of machines from copy and from the machines themselves; practice in lettering; original designs of simple tools or machines, or jigs to meet certain specified requirements which should be stated in the form of a problem for solution. During the last year of the course instruction in free-hand drawing.

For the fourth year it is proposed to allow a choice between advanced physics and mechanism and kinematics. Though both of these subjects are presented below, but one should be taken by any individual student.

ADVANCED PHYSICS.

HEAT.— A study of the facts and principles of heat by the use of such a book as Garnett's "Heat," a work written chiefly for mechanical engineers.

ELECTRICITY AND MAGNETISM.— A study of the facts and principles in which only elementary algebra and trigonometry are used. This course is covered in a clear and compact way by "Perkins' Electricity and Magnetism."

PRINCIPLES OF MECHANISM.— Analytical study of the fundamental principles governing the transmission of motion by rolling contact, sliding contact, by belts, link work and reduplication. Robinson's "Principles of Mechanism" will be found well adapted to the requirements of this course. Students selecting this subject should give a considerable portion of the time allotted to it in the development of such problems as are involved in the design of gear wheels, cams and other elements of machine construction, in addition to the regular time allowed for machine drawing.

While it may be possible that exceptionally strong and bright apprentices may be able to do more than has been outlined, and while some may desire to enter upon the study of subjects not given, it is believed the average apprentice will have very hard work to do satisfactorily the work specified, and that he will find his greatest profit in following the course as given rather than omitting a portion of that which is specified for the purpose of selecting something which may appear to be more attractive.

Every apprentice should be expected to read at least one technical paper.

APPENDIX "B."

(Form of Certificate of Apprenticeship.)

A. B. C. RAILROAD COMPANY,

MOTIVE POWER DEPARTMENT.

CERTIFICATE OF APPRENTICESHIP.

....
has served an apprenticeship as ....
at the shops of this Company at...
during the period from ....to.........................
and has made.....................hours time over 10 hours per day.

WORK ON WHICH EMPLOYED.

APPROXIMATE NO. OF MONTHS.	KIND OF WORK.
....	....
....	....
....	....

OFFICERS UNDER WHOM EMPLOYED.

NAME.	TITLE.
....	....
....	....
....	....

GENERAL RECORD OF APPRENTICE.

....
....

Supt. Motive Power.

APPENDIX "C."

(Form for Release of Minors.)

WHEREAS, The A. B. C. Railroad Company has agreed to take into its service .... a minor, subject to discharge at the pleasure of the company, and has agreed with our consent to pay him the compensation to be earned for his services, and has been authorized to take from him such receipts and acquittances as the said company may require.

AND WHEREAS, The said... by reason of such employment, will be subjected to great risk of personal injury from neglect of other employes, agents and officers of the said company, and from defects of machinery, and from other causes;

AND WHEREAS, In the event of injuries to the said....................... ...., whether resulting fatally or otherwise, the said

....or members of his family might make claims for damages against the said company:

Now, in Order to release the said company from all claims or liability for damages for injuries of any and all kinds, from any cause whatsoever.......................................the father, and.................................the mother, in their several and individual capacities, and acting as guardian for the said..., and the said ....himself, in consideration of the employment by the said railroad company of the said...in the service of the said company, and in consideration of the sum of one dollar now in hand paid by the said company, do hereby release and forever discharge the A. B. C. Railroad Company from all claims for damages, and do also further agree to release the said company from all claims and liability for damages arising out of any injury or injuries to the said ....resulting from the character of his employment, from the negligence of other employes, or agents or officers of the said company, from defects of machinery or any other cause or causes whatsoever, whilst a minor and whilst in the service of the said company in any capacity whatsoever.

Witness our hands and seals this...........day of................18....

................................[seal]

Witnesses: ....[seal]

....[seal]

....[seal]

....[seal]

Mr. Bradley: As this report is being distributed, I will present some thoughts on the subject in general. I would like, in the first place, to thank the railroad clubs and railroad press for the interest they have taken in the matter the last year in bringing it out and having it discussed, and it is pleasant to me to see that the mechanical men are disposed to discuss the question of the training and disciplining of men. I have occasion quite frequently to meet with transportation officers and with them it is a constant subject of discussion — the training and disciplining of their men; while in the mechanical associations it is a question that is hardly ever touched on. I know the superintendent of one of our connecting lines was to read a paper at Detroit, at the Central Association of Railroad Officers, on discipline, in September. He is to read a paper at the American Railway Association on discipline and training, and it is a question that the mechanical department men ought to interest themselves in somewhat. I notice from time to time that railroad managers are changing their organizations, and putting more and more the handling of the engineers in the hands of the superintendent. I am trying to decipher some reason for it. It seems to me that a possible answer to that proposition is that superintendents give more thought to training and disciplining men than the mechanical men do. Now, of course, we all know that railroad shops are not institutions of philanthropy; that they must be operated for results, and that men must be assigned to work where their ability will produce the best results. But, on the other hand, we all know of cases where a young man is kept on a drill-press or grinding away at something or other year after year, while if he was changed around a little his enlarged capacity would pay back in manifold the loss to the organization for the time he was changed off to a place where he would probably produce not so great a result as in the place where he had been.

Another question that comes to my mind: apprentice boys are at an age of the greatest character building, and if we get hold of them at that time and get possession of them, we have their loyalty and their good feeling; while if we allow them to get away from us and get under the influence of other people, we lose that loyal support which we might have had.

In closing my remarks I would like to read a few lines from an editorial in the Chicago *Times-Herald* of May 31: "It will probably surprise Senator Mason to learn that there are a dozen positions paying from $900 to $2,000 a year which the United States cannot find any person to fill. An examination was to have been held this month to fill them, but the Civil Service Commission was forced to postpone it because of a lack of sufficient applicants. The positions are those of draftsmen, assistant draftsmen and tracers of ship drawings in the Navy Department. Men are needed for the places, and the Civil Service Commission has found it necessary to issue an appeal beseeching patriots to apply for them." I simply read that because some people have said to me that there are lots of young men that have already fitted themselves out — fine mechanics, some of them, and draftsmen, and they do not find places. Now it seems that the Government is short of men of this class. It might be of interest to young men to know this; and while I would say that I do not believe it is any part of the business of a railroad to fit out young men to apply for these particular places, it does not do a shop any harm sometimes to have a young man leave the shop to go and accept a much better position. It stimulates the rest very considerably.

THE PRESIDENT: Gentlemen, the report of the Committee on the Apprentice Boy has been submitted to you. What do you wish to do with it? A motion to receive the report and open it up for discussion would be in order.

MR. VAUCLAIN: I move to receive the report and open it for discussion.

The motion was carried.

THE PRESIDENT: The report is open for discussion.

MR. VAUCLAIN: Mr. President, I think it would be impossible to discuss this report fully and satisfactorily at this time. There are a number of manufacturing institutions in this country which are considering this question very seriously, and are engaged in formulating a series of indenture papers for indenturing their apprentices; in other words, returning to the system, much more elaborated but on the same lines, that we enjoyed some twenty years ago. The difficulty that we would encounter here in discussing this report, and the length to which it might be drawn out, could be brought to your attention very quickly by referring to one item in the boiler shop course; that is, that the apprentice boy in the fourth series of three months is to be a holder on of rivets for boiler work. We find that it requires an Irishman not less than 200 pounds in weight to perform that work, and it would be a very difficult matter to get them to agree to this. I therefore suggest that on account of so much business ahead of us that we postpone the discussion of this report, if necessary, for another year, until we can get more data, and manufacturers who are now considering it will have some little experience, and we will be able to collect the various indenture papers that will be put forth and have a fuller discussion than we are able to have at this time.

MR. ROBINSON: Mr. Chairman, I simply rise to call attention to one paragraph in this report — the last recommendation of the committee: "Your committee therefore recommends that a standing committee on this subject be appointed and that that committee be empowered to enter into whatever correspondence may seem necessary with the managements of railway companies with a view to securing the proper treatment of apprentices and the acquiescence of the managements in the appointment of a necessary foreman and other matters, and that the committee also be given power in behalf of this Association to negotiate definitely with universities or institutions of learning for the establishment of courses in specified districts, as they may see fit, without waiting, if the committee deems right, for the approval of next year's convention." To those gentlemen present who were in the hall during the discussion last year, or who read the report presented by the committee last year, or who have read the discussion in the Proceedings, it is not necessary for me to say that last year a very great deal of attention was given to the matter of night schools and technical education of apprentices outside of the shops. Those of you who have read this report will find that what the committee considers the most important point in the matter of the handling of apprentices is that the charge of apprentices should be given to one particular and well qualified person, that person to be known as the foreman of apprentices, or by some such title. These are two very large fields of one very large subject. Your committee feels that this is about as important a subject as either this Association or the Master Car Builders' Association can take up. There have been reports presented for two years. Mr. Vauclain has proposed that the matter be postponed for another year. I would respectfully, as a member of the committee, call attention to the request which we make that the committee be made a standing committee; that it be given very large power; that it would further assume the responsibility of communicating with the manufacturers who are at this work on the indentures, as Mr. Vauclain informs us. I believe that the standing committee to be appointed — and the other members of this committee agree with me — should be authorized to go ahead on the lines outlined in last year's report and negotiate with the University of Chicago, or Purdue University, both of which universities entered very heartily last year into the negotiations which we embarked on with them. The standing committee ought to be empowered to negotiate with them, and if possible start in specified districts experimental schemes of university extension lectures, associated with night schools, either to be established by the roads or under local supervision, without waiting for another year. We believe also that the standing committee to be appointed ought to have authority and should be instructed to correspond through members of the Association with the railway managements and find out the prospects of the appointment of officials to be known as foremen of apprentices. In fact, we believe that a committee ought to be appointed which can do something, and not simply a committee which will summarize experiences and report next year and be again put over for another year to be discussed in the year 1899.

MR. SINCLAIR: Mr. President, I am one of the Master Mechanics who have had to educate themselves in every part of the science of the business. I know the difficulties that are encountered in securing an education for oneself. I know the great toil that is necessary and I know how many ambitious young men have fallen by the wayside when they wished to go along and obtain a good education in the business. Consequently I do not think anyone sympathizes more earnestly than I do with those who are trying to get an engineering and mechanical education. At the same time, I do not think it is the business of this Association or the business of the railroads to educate apprentices as mechanical engineers. From my experience with the apprentices in railroad machine shops and the other kinds of railroad apprentices I think the great reform necessary is a change that will enable the apprentice to learn the trade — the trade that he goes in there to learn and not to keep him as a laborer and no mechanic during the whole of his course, which is very common in a great many shops. I find that in many shops the apprentice goes in as a mere laborer. He is kept at the job at which he shows himself to be most handy, for years, and there is no systematic course to let him learn the trade step by step as it used to be in the old days. If any change is very urgent at the present time it is the forcing by public opinion of our shop managers to arrange the work for the apprentices from year to year something on the system adopted by the Norfolk & Western so that they will have a chance to learn the trade. If they get that, those who are ambitious and those who are persevering will come to the top in the line of mechanical engineers and the drones will fall behind.

MR. VAUCLAIN: Mr. President, I agree with Mr. Sinclair in a great many things. I wish to say this to the Association, however: In any large manufacturing institution, by employing apprentices, taking in a regular number of apprentices every year, it is apparent that something would have to be done with those apprentices after they had served their apprenticeship and been declared masters of their business. I am sorry to say that it has been the custom of a number of people, not only manufacturers but others, to employ, as much as possible, cheap labor. Now we have mechanics in our service who have been with us over forty-five years. We think that it is desirable to hold on to our old employes, our experienced men. We therefore feel that something must be done to handle the apprenticeship question, so that the apprentices will not interfere with the retention of the old employes. One idea that we wish to incorporate in the indenture papers that we have under consideration is this: that while the apprentice will be permitted to obtain a thorough knowledge of the business, at the expiration of the apprenticeship he will be paid his bounty, an amount sufficient to enable him to travel half way across the continent in search of a position. But he will be discharged. We will have the option of hiring him over again if we need any men at the time. But if we are not in need of any additional men at that time that young man will have to go off and seek a situation elsewhere. This will have the effect, that during the course of his apprenticeship he will ever have before him the necessity of applying himself closely and making himself master of his business, because as soon as he is free he is cut loose from the institution he was with and must go and seek employment elsewhere. I think it is outside the province of the Master Mechanics' Association to educate apprentices. I think that should be intrusted to the managers of the various railway workshops and the manufacturers throughout the country. It does not relate simply to the locomotive building profession or ordinary machine building, but it relates to all other trades; and it is high time that manufacturers particularly should take up the question and fix it so that instead of having a number of manual training schools — very small manual training schools — throughout the country, the workshops of the entire nation should be opened up as manual training schools, and that after the young men are trained to be masters of any certain business that they may engage in, they may be given the opportunity of going out into the world and proving to others that they are masters of that business.

Mr. Bradley: The few minutes left before the noon hour probably might be taken up with this question. I think the railroads have some interest in this matter as well as the manufacturers, and I think that the railroads more and more are beginning to feel the need of having the loyalty of their men. I think a good way to get the loyalty of a man is when you have a good man to keep him, and if he has got a good son, to take him into the service with his father and teach him some trade and keep him. It is well enough not to take on more than you need. But I think instead of getting a boy whose natural home and allegiance are in Philadelphia, you had better get a boy whose natural home and allegiance are in your own place. Then we will have boys who will want to stay with us. Their home is fixed right there. I think that railroad shops will always want to have some apprentices, and the question of taking too many or not enough is one of those questions we have to meet anyway. But I think it is perfectly proper for every railroad shop to educate its own men, select them from the sons of the employes now in the service and keep them right there; have a homogeneous affair, have some loyalty and good faith promoted in that way between the men and the company.

MR. MORRIS: I move you that the recommendations of the committee be accepted, that a standing committee be appointed to report from year to year to this Association on this subject.

(Seconded.)

MR. LEEDS: In adopting the recommendations of the committee do you propose to grant their recommendation to give them authority far in excess of what we have given heretofore?

MR. GILLIS: I would like to make this remark in regard to what Mr. Vauclain said. I have taken always the greatest interest in the young machinists and the young apprentices in the shop. I found this condition in almost every shop I have been in, a condition that was mentioned here a short time ago — men were put on one machine and continued there, serving their whole time there. So I determined that if I ever had an opportunity to do anything with the apprentice system I would have it differently conducted; that I would have men in the shop given an opportunity to learn the trade — whether they chose to avail themselves of that opportunity or not. You will find that certain boys are bright and apt. Some foremen would try to shove such boys ahead, and they will get all the chances in the shop, while some other poor fellow will not get any show at all. I think that ought to be changed; each apprentice ought to have an opportunity, and I think we give them that opportunity in our shops. One other feature brought out by Mr. Vauclain was, what shall we do with the apprentices after we have graduated them? My opinion is that we ought to turn them right loose. It is the best thing you can do with a boy. Let him get out and hustle for himself. If he is a good fellow and if he lives in the town he may come back again and he will be a much better man, a more self-reliant man. He will learn new ideas and he will bring back to you new ideas. Then, as to this Association taking up this matter, I think it is a proper thing for the Association to take up. We do not want to interfere with anybody else's business. I do not think there is any Master Mechanic or Superintendent of Motive Power who wants to run some other man's shop; but he does want, if possible, to have the mechanics of the country, whom he will have to employ from time to time, properly educated, and when he needs men he wants to be able to get men who will be of some value to him. We start today to employ a large force of men; what do we find? We find that we get a few first-rate mechanics; we get a large number of mechanics who are only half-rate mechanics and they abuse our tools and get out poor work and make it expensive. I think it is to the interest of us all to have a competent grade of mechanics maintained in this country.

MR. VAUCLAIN: I would like to hear from Mr. Schlacks on this question.

THE PRESIDENT: One moment. I am not sure whether the motion submitted by Mr. Morris had a second.

MR. MACKENZIE: I second the motion.

THE PRESIDENT: That being the case, if Mr. Morris still holds to his motion, we must confine the discussion to that proposition. Will you recite your motion, Mr. Morris?

MR. MORRIS: My motion was that the recommendation of the committee be accepted and a standing committee be appointed to report to this Association. There is a modification of that which I intended to make. The recommendation of the committee is that they should be empowered to enter into whatever correspondence may seem necessary with the managers of railroad companies. I desire to modify my motion by eliminating that part and providing that they shall report to this Association, and that the Association make the recommendations to the railways if necessary. I do not think it is wise to provide that they take up the matter with the managements of the railways themselves. It should be taken up by this Association.

THE PRESIDENT: Does Mr. Mackenzie concur in that modification?

MR. MACKENZIE: Yes, sir.

MR. ROBINSON: I wonder if Mr. Morris understands that what the committee is chiefly anxious to get at is to find out whether or not it is possible in this country to have something like the system which is in force in other countries, whereby the apprentices are put distinctly under charge of one person with a special title. It is not necessary to say that the committee in the course of a year could probably do nothing more than communicate with the managements directly, or through the members of this Association on the roads, and find out by next year what chance there is of any considerable number of roads with large shops taking hold in earnest of a systematic scheme, with one man at the head of it called the foreman of apprentices. That is the correspondence which your committee thinks ought to be undertaken with managements to find out whether that scheme can be adopted, and I think it is a pity to seem to state that a standing committee has no authority to correspond. I think it can really do some good work, and next year it ought to be able to say what roads are prepared to take up a systematic scheme and appoint a man called the foreman of apprentices, etc.

MR. BRADLEY: As chairman of this committee, I would like to say that I concur with Mr. Morris. I really believe that a committee ought to be appointed — I do not say this committee; but a standing committee ought to be appointed. Perhaps there are other members much more able to handle the subject than we are, and I think that ought to be taken into account. But a standing committee — not this committee, but a standing committee — ought to be appointed.

MR. SPRAGUE: I think that is a move in the right direction, if it can be carried out; but it is not strictly logical. I remember being placed in that position myself, thirty-two or thirty-three years ago, on the Central Ohio Road at Zanesville, now a part of the Baltimore & Ohio. The old Master Mechanic, Mr. Ball, said to me one day: "Sprague, I want to put you down in one end of the shop and put you in charge of a lot of apprentices. We have got a lot of boys here who are neither learning nor earning anything. I want to put them in charge of a man and see if we cannot get something good out of them." He made that arrangement and I was given charge of them a year or two, and I believe that is the only plan to be followed. Some of those boys now are Master Mechanics.

MR. MILLER: If in order, Mr. President, I would like to say in connection with that motion, that I would not like the impression to go out that we, as Master Mechanics, believe that we ought to send our apprentices out, when their time is served, to increase the number of tramp machinists that we are already afflicted with. Our own apprentices are better in carrying on the work and are more profitable to our shops than nine-tenths of the machinists that we hire that are tramping over the country. I believe what we need today is to encourage men to feel that they are at home in the shop where they served their time, and it should be our business to make them good mechanics, or get rid of them and get boys that would develop into good mechanics. [Applause.]

MR. SPRAGUE: I think that is the wrong direction. I think that self-reliance is the great thing for a boy to have. I think when he has learned his trade the best thing is to go on his own resources and he will make a better man. This idea of a boy feeling that he is patronized and sustained by the shop where he was employed detracts from his self-reliance. I am satisfied of that.

MR. QUEREAU: I would move as an amendment that a standing committee to report on the apprentice boys be appointed. That would eliminate any limitation of their power, would give them no specific powers, and would allow them to use their judgment. (Seconded.)

THE PRESIDENT: Is that amendment accepted by Mr. Morris?

MR. MORRIS: Yes.

THE PRESIDENT: The Secretary will read the final clause of the report embodying the recommendations of the committee as modified by the motion and the amendment, so that you will all understand what the question is.

MR. CLOUD: I think it would simply come down to the last motion, that a standing committee be appointed to report on the apprentice boy, in lieu of everything that has gone before.

THE PRESIDENT: Does the membership understand if that is decided in the affirmative the standing committee will have all the powers which are conveyed by the wording of this clause?

SEVERAL MEMBERS: No.

THE PRESIDENT: I think it is in very doubtful shape, then.

MR. QUEREAU: My object in making that motion was that there seemed to be on one side an assumption that the recommendations of the committee would lead them to exceed their proper charge. I put the motion as I did, believing that the standing committee would have good judgment enough to stay within their powers. It would remove the appearance of criticism which seems to be present here this morning, and we could rely upon the judgment of the standing committee appointed to report upon this subject next year.

MR. BRADLEY: Mr. President, I would like to say for the benefit of the members, that the University of Chicago has an organization of university extension course of lectures, and in our correspondence and our meeting with them last year they showed a disposition to take hold of this matter, and it would seem to me to be well for members to understand that if there is anyone who has a disposition to try to make a start toward some night school and cannot get hold of a suitable instructor in the locality, he might communicate with this standing committee and then the Chicago University might give them some help. At least when we had a meeting with the representatives of the University they showed a good disposition along this line. I do not know whether any change has come over their feelings since or not.

THE PRESIDENT: The hour of twelve has arrived, and under the By-Laws we must take up topical discussions, unless you decide to continue this discussion. [Question called for.] The question, as I understand it, is that a standing committee should be designated to keep this subject alive, continue the investigation of it and report at the convention of 1898. I also understand that it is not the intention of the mover to convey to the standing committee all the powers which are recited here in the recommendations of the present committee; that they will not be empowered to negotiate for a special course of instruction. Is that correct? Do you understand the motion? All those in favor will please say "aye"— opposed "no."

The motion was carried.

THE PRESIDENT: Do you wish to continue with this discussion now, or proceed to the topical discussions?

MR. HENDERSON: I move that the topical questions be taken up.

THE PRESIDENT: That will not require any motion. The hour of twelve has arrived and the topical questions are in order.

Mr. Lewis: Before taking up the topical discussions, I wish to call attention to the fact that we have fourteen topical subjects on the list, and that yesterday during the noon hour we disposed of only two of those subjects. While, of course, one of those subjects, the subject of compound locomotives, was an interesting one, and the time devoted to it was well spent, still it points to the necessity of economizing our time, and I would therefore move that the topical discussions be confined to ten minutes, and that no member be allowed to speak twice on the same subject until all other members who wish to speak have been allowed an opportunity to do so.

The motion was carried.

The President: At the expiration of each ten-minute period the gavel will fall without reference to who the speaker is or what stage of his remarks he has reached.

The next topical question in order is No. 3: "Cylinder clearance. Is the large cylinder clearance common in American locomotives economical?" To be introduced by Mr. Angus Sinclair.

Mr. Sinclair: Mr. President, this is a subject that has not been brought before the Association for a long time, and I think there is a good deal to be said on both sides; consequently I gave it the unusual dignity of writing out a series of arguments on the side I intend to take. I find, however, that this motion of Mr. Lewis comes like a wet blanket upon me, for I would not get my discussion half finished when the gavel would fall. Therefore I will just briefly state that I believe locomotive designers are wasting steam by the enormous ports and steam passages which they are using with modern locomotives. I had a considerable experience in traveling through Europe last year and investigating for myself the cause of the difference in fuel consumption of the locomotives here and there. I could see nothing that favored the European locomotives except that they had shorter steam ports. The boilers were all on our side. The design of cylinders ought to be on our side too, according to the principles of stationary engine designing. But there is no doubt that the European engines are doing the work with from twenty-five to thirty per cent less fuel than our engines require, and there must be some cause for that. We have a better boiler; we have more liberal heating surface, and our engines are certainly handled as skillfully and intelligently, and yet these are the facts of the case, and it is only in the steam ports where I can think the waste may be. The dictum is, make the steam ports and passages as large as possible to get the steam into the cylinders as near to boiler pressure as possible. That is all right in stationary practice where there are very short steam passages, where the distance between the steam ports and the cylinder is very short; and they have an advantage in another way—they can regulate compression so that the compression line will come up to the admission line at the beginning of the stroke. That cannot be done with locomotives, for the reason that the nozzle regulates the back pressure to a great extent. If you regulate your compression for a certain sized nozzle and it gets restricted through gumming up or through a change of nozzle, you increase the back pressure, and the back pressure increases the compression, so that you have an engine that works against itself. Therefore the rule of stationary engine designers of getting as large passages as possible and making up by compression for the loss of steam cannot be followed in locomotives, and I do not think enough attention has been bestowed upon that.

It used to be said that there was no difficulty in getting the steam into a cylinder if it could be got out, and it certainly gets let in with a vengeance the way that the indicator diagrams show the way the pressure reaches the piston. Another thing: it has been demonstrated that initial wire-drawing gives some superheating to the steam. Superheating is of very great importance to a locomotive because it tends to reduce the great condensation that occurs at the beginning of each stroke. I think it would be a very good thing if those who are experimenting with locomotives now would reduce the piston clearance to the very lowest limits, and find out what the effect of that was. Unless that is done I think we are to a great extent traveling in the dark, traveling to greater excesses of clearance and throwing away fifteen to twenty per cent of the steam at each stroke, and I think that something should be done to see whether you are going in the right direction or not. [Applause.]

MR. HERR: I question very much the accuracy of Mr. Sinclair's statement that the European engines are showing twenty-five per cent more economy than the American engines in the same work. I think it should be borne in mind that the English engines usually use a different kind of coal than the average coal used by the American engines, and that very likely the better performance is due to the better quality of coal. Of course, there is undoubtedly a wastefulness in large clearances, and contracting the space tends toward economy, but I doubt very much whether anything like the amount of economy stated can be found.

MR. DAVID BROWN: Comparing the English engine and the American engine is all very well, but they do not load their engines there as we do here. You can say, on the other hand, that they do not keep them for ornament. That is all right. I know all about them; know all about the principal roads over there; know just what they are doing, and they work very well. But put them down to the same work that locomotives do in America and they are not in it. [Applause.] I know it is an old saying that an English engine earns itself twice in a year and an American engine earns itself three times in a year. That is an old expression they used to make use of, showing that the American engine did much more work. When I came to this country I was scared to see how they would work them. They would not run an exhaust over there as they do here. With regard to the clearance, I am in favor of giving them just as little clearance as possible. We never exceed three-eighths. The trouble is, the piston comes out a little thicker than we figured on. We get down to five-sixteenths, and if we get a quarter we consider it safe; give it a little more on the front end than the back. With regard to the ports, when we give them an inch and a half port we probably are going a little too far. I think an inch and a quarter, not less, is good enough, but with inch and a half we are wasting some steam. [Here the hammer fell.]

THE PRESIDENT: The next is Subject No. 4: "The Use of Piston Slide Valves for Simple Locomotives." Mr. William Forsyth.

MR. FORSYTH: Mr. President and Gentlemen,—The subject of piston valves for simple engines has probably been referred to me because we happen to have two simple engines with piston valves, while the majority of engines in this country equipped with piston valves are compound. I do not know of any particular difference nor why there should be any distinction made in the service; but the slight experience we have had with those two engines has shown one or two points which it might be interesting to explain. One is that it is rather difficult to set the piston valves. One of these valves is in the saddle directly under the steam chest and is quite long, and it is difficult to fix the port lines in their relation to the valve accurately, and I have found that roundhouse men in dealing with piston valves, unless they are trained to it carefully, do not set the valves right, and we had to have them set over quite a number of times before we got them right, and finally had to send a man from the office to see what was the matter. There was one peculiar thing that we found, that the ports in the bushing were not truly at right angles with the axis of the bushing; that they were slightly angular, so that the admission line, measured from below, was perhaps one-sixteenth of an inch different from what it was above, and it is important therefore in making bushings for piston valves to see that the port lines are described by the boring bar. Another thing we found — that the packing ring in the piston valve is really the cut-off point, and there is some metal on the valve extending beyond the packing ring, and this metal acts as an interference to the free admission of the valve on a small port opening. We found at once when we commenced taking diagrams that we did not have a good admission line, and in order to improve that we trimmed off the corner of the piston outside the packing ring, and rounded it off so as to give the steam as free a chance as possible to enter the port. In doing that we obtained an increase of mean pressure, under the same conditions, of fifteen to twenty per cent. Our experience with piston valves has shown that when made of large diameter and similar to the designs used by Mr. Vauclain in his engines, they will wear very little; they will give a very good service, and strange to say the wear of the packing ring is not so much on its circumference as it is on its sides, and that points to the importance of making the depth of the ring as great as possible and as deep as you can get a cast-iron ring to spring on. The advantage of piston valves is in their small amount of friction, their ease of lubrication with high pressures, and I believe that with pressures of 180 pounds and above that, they will be found to have advantages over the ordinary slide valve. And incidental to this little friction, this small amount of friction with piston valves, is the freedom of the use of the reverse lever.

Working engines to full steam at 200 pounds pressure, it is possible to move the reverse lever very easily and thus change the cut-off at will. I believe that a good portion of the wastefulness of some engines is due to the fact that the valves work so hard and it is so difficult to change the reverse lever under steam that the engineers do not do it and do not take advantage of shorter cut-offs when it is possible to do so.

MR. FOWLER: I would just like to say one word in regard to this matter of piston rods. There is a method of packing the valves which I ran across on some of the western engines a few years ago which overcomes entirely the difficulty of having the packing set back from the edge of the valve. The ring for the packing is cut in the ordinary way clear around the valve, and then on the lower half of the valve where it sets over the port a piece is riveted in so that the bottom of the valve, as it passes over the port, has no packing whatever. The packing is sprung in over the top. The result is that the edge of the valve can be made perfectly sharp. It is not necessary to round it out at all, and the valve can be set from the end of the valve and need not be set from the packing. It may be set any distance back. In that way you have the valve resting on its seat, traveling backward and forward. That packing is working very satisfactorily where the ports do not go all the way around the valve, but the weight, having it on the bottom, gives you a clean, straight piston valve resting on its seat, with a ring back over the top to prevent steam passing from one end of the cylinder to the other. That is being used quite extensively on some of the western steamboats running on the lakes, and is doing most excellent service there, being set in the way I mentioned.

MR. QUEREAU: To my mind there is one objection to the piston valve, and that is that it is very difficult to put an Allen port into it. In my estimation, an Allen port is a very important thing in engines working as hard as we are working our engines.

THE PRESIDENT: The next subject is No. 5: "To what extent and under what circumstances is it permissible to use water on bearing surfaces of locomotives?" Mr. Mitchell.

MR. MITCHELL: All of us intend to design our locomotives so that there will be no difficulty in lubricating them perfectly with oil. All of us have locomotives, however, that have very small journals or crank pins where the bearing pressure per square inch is greater than it should be, which engines are liable to run hot. We all know that water can be used on a journal and produce sufficient lubrication so that the journal will not cut, provided the water is running constantly. In fact, I know a stationary engine that ran three months with nothing but water on the journal and no trouble occurred, and I think it is permissible to use water on these locomotives that are liable to run hot, when by doing so you can prevent a delay to an important train, or when you can get a train over the road without detention. I do not think any of us would indorse the use of water on a bearing except under such circumstances.

MR. HERR : I agree with Mr. Mitchell's last conclusion, but I would have to take exception to his statement that water is a good lubricant. I doubt very much whether that can be shown. I have known of certain kinds of bearings to run very successfully with water and no oil. I have in mind some dynamos that have run for years without a single drop of oil and quite successfully ; but that is rather a peculiar condition of a bearing. The motion is very rapid and the weight and conditions of pressure are rather abnormal and very different from what they are in railroad practice generally. My idea of the use of water on locomotive bearings is in emergencies, as Mr. Mitchell states, and I must testify that it does excellent work. There is another way in which water can be used very satisfactorily, and that is not on the bearing itself but on the parts that bear on the bearing to carry away the heat that is generated and allow the oil to do its work. I have used it thus very successfully on rods and pins.

MR. GILLIS : I can say that I have seen a locomotive run for nearly two months with nothing on the driving boxes whatever in the way of lubricants but water. Holes were drilled down through the top of the driving box. After this service for two months the journals were perfectly smooth, in fact highly polished, and did not show any apparent wear. The shoes and wedges on that engine were badly cut and there was a good deal of trouble with the shoes and wedges, and they were oiled and required considerable oil, but the bearing itself and the axle were in perfectly good condition. Another engine which had a run with water on driving box showed no trouble at all either with the journals or with the shoes and wedges.

Mr. West: We had a great deal of trouble with the driving boxes on our engines until we applied water pipes to the journals or to the axles, but we did as Mr. Herr says, we ran the water between the driving boxes, keeping the axle cool. We found the great difficulty was that in starting out the axles would be warmer when leaving the engine house than on an engine which had run fifteen or twenty miles. We first tried water on top of the journal box, when the engine was leaving the house, but afterward we ran the water continuously from the time the engine came out until she stopped — the water running on the axle between the driving boxes, and that kept the journals cool.

Mr. George Gibbs: Water is a very valuable adjunct, in my opinion, for cooling down a journal. If you once get the journal cool then oil can be used to advantage. I know of a dynamo that has been running ten years without a drop of oil on its bearings. The reason we could not run oil on the bearings was that the heat from the armature kept the journals so hot that no oil would go on them. After running ten years the wear is very small. I think that water for cooling down the journals will be found valuable.

Mr. Henderson: Mr. West spoke of the water running between the driving boxes. I do not think that is exactly clear.

Mr. West: We ran a stream of water over the rear axles. Our rear axles are inclosed in what may be called a hot-air furnace. The ash pans are arranged to inclose the axle, and it gets very hot with the heat from the grate. We run a perforated pipe between the driving boxes from one side to the other. We let the cold water from the tank on the engine run on to that axle. We do that over the entire trip—keep the water running.

Mr. Herr: I would like to ask Mr. Gillis whether he had any cellars.

Mr. Gillis: I would like to say that there were cellars in the engines. They were there; that is all.

Mr. Herr: Any oil in the waste?

Mr. Gillis: There might have been some oil originally, but there was no oil put in during that time.

Mr. Mitchell: It seems to me if that dynamo ran ten years without wearing the axle, water must be a pretty good lubricant.

Mr. Gibbs: The pressure is very light. There is practically no pressure there.

Mr. Sinclair: One of the most difficult bearings to keep cool that I ever had anything to do with was the thrust bearing of a large steamer. I had considerable experience looking after that part of the mechanism at one time, and we always used a brush of tallow around it, and a stream of cold water was always kept running on the bearing. I do not believe it would have done well without the tallow. But after you have gone through a long voyage you do not see any difference in the quantity of tallow left, but the water and the tallow seemed to make a slight film on the journals that was most effectual in preventing heating.

Mr. McIntosh: I have had some experience in the use of water on journals. We found that by using a stream of water constantly in connection with a very little oil, that overcame the difficulty entirely, and we ran it for years in that way successfully. My experience in using water on the bearings of a locomotive is that it is only useful in absorbing the heat.

The President: Subject No. 6: "Manual *vs.* Automatic Control of Compound Feature of Compound Locomotive." If you will permit me to speak from the chair, I will open the discussion.

As I understand it, compound locomotives of every sort and kind have some sort of manual control, and I believe I am right in saying that in every compound engine there is a connection from the valve mechanism to the cab by which the engineer can at will change the working of the engine from compound to simple. That I believe is characteristic of all engines, so the question under debate seems to be whether it is better practice to have automatic control changing the operation of the engine from simple to compound. In the Vauclain type of compound locomotive, with which I am most familiar, the change is effected manually at the will of the engineer. The engine is usually started simple and continues simple until conditions justify the change, when the engineer by moving a lever readjusts the valve mechanism in such a way that the engine from that time on works compound. In most other forms of compound engines the change from simple to compound working is automatic and is usually accomplished through the medium of an intercepting valve. My leanings are in favor of the manual control; but in stating that fact I have to say that my convictions are simply based on the fact that we have had very successful results from that form of control and we have had little or no experience with engines in which the change from simple working to compound working is automatic, and it seems to me that one of the penalties which you have to pay for having the automatic feature of control from simple to compound is, increased amount of mechanism and additional parts to maintain with additional risk of failure, and I have no argument other than that to support my opinion that the manual control is good enough for all practical purposes.

Mr. Morris: Mr. President, we have had no experience with manual control. Ours is what I might term a modified automatic, wherein the engine will automatically go into compound after starting, and if the engineer desires to work the engine simple, he operates the emergency valve, so termed, which throws the intercepting valve to direct the pressure into simple form. We have really nothing to criticise about that. Our engines have given us good work and our engineers seem to like that system very much.

Mr. Herr: As I understand the question, it is as to which is the most advisable, a compound locomotive which can be worked at the will of the engineer as a simple locomotive indefinitely, or one that can be only worked simple during a certain number of revolutions. I have under my charge at the present time locomotives of both types, and I have only time to state here today that the only locomotive that has been giving us a serious amount of trouble is one that is not susceptible of being worked simple at will.

Mr. Mitchell: There are times, when you are nearing the top of a hill, when you want to put live steam into the big cylinder, and that is the time you want your manual arrangement.

Mr. George Gibbs: Mr. Mitchell has covered the point I was going to bring out. My experience has been with the Vauclain type entirely. Formerly I was under the impression that it would be advisable to fix it so that the engine could not be worked simple unless the reverse lever was in the corner, thinking that the engineer would work it too much. But our experience with them has not developed that difficulty. In fact, we find that they very soon catch on to the fact that the starting valve is of very little assistance except when they are going very slow, and there are times on a grade when it is very desirable to keep the engine in simple gear for quite a distance.

MR. BRADLEY: Is it not a fact that when you can throw live steam into the large cylinder, that is taken advantage of to increase the loading of the train, and the result is very bad practice?

MR. QUEREAU: A year and a half or two years ago there were published in the proceedings of the North-Western Railway Club the results of fuel records made by compound engines, one of which could not be converted into simple at will and the other could be. The fuel economy of the compound locomotive which could not be converted into a simple locomotive at the will of the engineer showed the best, because they would haul heavier loads, and the coal which was used would divide among more units and made less coal per unit of load hauled.

MR. HENDERSON: I would like to indorse what the president said, that is, it seems more logical if you are going to have a locomotive which will work automatically and you can prevent it from working automatically by hand, why not make it work by hand and not automatically and save those different parts?

THE PRESIDENT: Mr. Vauclain.

MR. VAUCLAIN: Mr. Henderson has covered the point I was going to make.

THE PRESIDENT: Subject No. 7: "Causes of irregular wear of cylinders of locomotives carrying high steam pressure." Mr. W. A. Brown.

MR. BROWN: We find in engines with large cylinders, carrying high pressure of steam, an excessive wear in the top of the cylinders much more than in the bottoms. This wear usually commences about an inch and a half or two inches from the end of the stroke and decreases toward the middle of the stroke. We find excessive wear in the bottom, owing to the drag of the piston. This we have been able to overcome to a certain extent by the use of extended rods and other devices, but if the wear continues more at the top than at the bottom it is a question whether the extended rod would be desirable or not. The question is, what should be done to overcome this wear in the top if it is going to exceed that in the bottom? It occurs to me that it may be due to the difference in the quality of the iron in the top of the cylinders; being confined in a mold adjacent to the mass of iron in the steam chest, it may be of a softer quality and more open and porous. If that is the fact, it may, perhaps, be overcome by the use of bushings, as they are more likely to be of a uniform quality. This, however, is a matter for experiment. The idea also occurs that wider rings should be used, perhaps, to overcome this. There is no evidence of anything being in contact with the top part of the cylinder except the packing rings themselves, and this appears to occur with packing rings all the way from five-eighths of an inch in width up to one and one-eighth inch. The bull rings and the piston show no evidence of coming in contact with the wall of the cylinder at all, but they do show, after boring the cylinder out and taking out what you would think to be sufficient to clean out the bottom, you find the top walls of the cylinder are worn more than the bottom. Now, I would inquire if any of the members who have bushed cylinders with iron of a good quality and uniform density have noticed any beneficial results — any decrease of this wear. The only way that I could account for it was by the difference in the quality of the iron in the different parts of the cylinder.

MR. WEST: In answer to Mr. Brown, I would say that we have bushed several cylinders — but I would like to ask first whether this trouble was with the solid piston or with the bull ring?

MR. BROWN: With the bull ring and the snap ring packing.

MR. WEST: We found the same trouble, but after bushing the cylinders and boring out the cylinders without the bushing, when we abandoned the solid pistons with the snap rings we overcame that top wear. I think the solid piston in connection with the off-set cross-head is the secret of the top wear. With the alligator cross-head we have no trouble whatever with the same engines and the same grade of iron.

MR. HERR: I had a little experience with the irregular wear of cylinders, but I was ready to attribute the cause of it to a different thing than was mentioned. I was inclined to think that it was due to the fact that the bull ring did not fit the cylinder well enough. It has been stated that in one case the bull ring did not touch the cylinder. Probably that was the cause of it.

MR. BROWN : The bull rings are of the usual difference of diameter, say one-sixteenth or one-eighth smaller than the diameter of the cylinder. That is the usual practice or the more general practice of the difference in sizes, I think.

THE PRESIDENT : We will pass on to the next subject, No. 8 : "Lead for Passenger, Freight, and Yard Locomotives." This subject was assigned to Mr. E. L. Coster. We understand that Mr. Coster is not here, but that his remarks have been reduced to writing and are in the hands of Mr. Lewis.

Mr. Lewis read the following discussion submitted by Mr. E. L. Coster :

Your Committee on Subjects have honored me with the request that I should open the discussion of Topical Subject No. 8—"Lead for passenger, freight and yard locomotives," and in complying therewith I will state that this subject was suggested by me for noon-hour discussion with the object both of directing attention to, and stimulating interest in, the very important advantages to be derived from the intelligent sacrifice of the full gear lead to that at the running cut-off; prominent among which advantages are: increase of power; decreased expenditure for repairs; fewer delays and less annoyance due to hot pins, driving boxes, etc.; and increased economy in the use of fuel, resulting from a better distribution of the steam.

Another object which I had in view in suggesting this subject for discussion was the discovery whether, in the opinion of this Association, it would not be desirable to appoint a committee to further investigate some of the points developed by Mr. C. H. Quereau, in his admirable paper on "Locomotive Lead," which was read at the February meeting of the Western Railway Club.

In this connection the following subjects occur to me as being worthy of further consideration :

1. When adjusting the lead, what should we consider the running cut-off for passenger, freight and yard locomotives, with both plain and Allen valves, especially in the case of the long-stroke engines now coming into use?

2. What is, approximately, the most efficient lead at the running cut-off for the above three classes of locomotives, with both plain and Allen valves, and what should be the maximum and minimum limits of variation of the same?

3. What should be the maximum and minimum limits of full gear lead for the three classes of locomotives, with both plain and Allen valves?

4. What is the most desirable method of diminishing the lead—reducing the angular advance of the backing eccentric; reducing the angular advance of both eccentrics; increasing the lap; combination of methods, etc.?

5. It having been conclusively demonstrated by Mr. Quereau that in the majority of cases excessive compression, producing the characteristic loop in the admission line of the indicator diagram, results from pre-admission, rather than from early exhaust closure, excessive back pressure, or deficient clearance, would not the proper adjustment of the lead at the running cut-off enable us to diminish the volume of the clearance spaces and obtain the resulting increased efficiency in the use of steam, without the disadvantage of excessive compression?

In a paper on "Lead for Locomotive Valves," published in the "Organ fur die Fortschritte des Eisenbahnwesens," by Herr August von Borries (a translation of which appears in the current issue of the *American Engineer*), that authority states that "For the determination of the most suitable dimensions for the width of the lead opening, the ordinary indicator cards give almost no assistance, since they do not mark the forward motion in the neighborhood of the dead points, or the internal frictional resistance of the machine. These mistakes are frequently made through an imperfect understanding of the case, since good admission lines can always be obtained by increasing the lead. As illustrating this statement it may be said that the first standard freight locomotive with an Allen valve and a large lead gave faultless admission lines, while the older and better working locomotives with the common valves gave cards with the admission line falling off very decidedly. . . . . It is, therefore, necessary to guard against accepting an indicator card as an evidence of the good action of the steam and the satisfactory operation of the valve motion. In this matter we must rely upon practical investigation alone in order to obtain trustworthy information."

In view of these considerations it appears eminently proper that this Association, with its almost limitless opportunities for experimental investigation and acquisition of practical experience, should undertake the study of the important subject of locomotive lead, and thereby carry the development of the American locomotive still further toward that point at which, in the words of a distinguished engineer, we "attain the maximum economy in the use of fuel with the greatest efficiency of the machinery."

THE PRESIDENT: As nobody rises to discuss this question, we will pass on to the next subject, No. 9: "Broken Staybolts." Mr. Lawes.

Mr. Lawes read the following discussion:

The Committee on Noonday Topics has assigned to me the duty of opening the discussion on "Broken Staybolts." Under the presumption that you will readily grant me permission to qualify the phrase, I shall be pleased to present to you a few thoughts on the subject of "Partially Broken Staybolts," which, in my opinion, is a topic of much greater importance, since partially broken staybolts are the more difficult to detect. In fact, so far as my investigation goes, they are never detected under the old methods, and must be regarded with suspicion.

For some years hollow staybolts and drilled staybolts have been used to a limited extent, but for some reason — or no reason — neither one has been put into general use, although, as I believe, the protection afforded is invaluable.

To satisfy myself as to an inspector's ability to detect broken and partially broken staybolts, I have had the staybolts in thirteen engines drilled during the past year.

The plan adopted was to have the inspector locate all the broken staybolts he could find, after which the staybolts in the fire box were drilled, including those marked by the inspector as broken. In the first fire box tested in this manner the inspector found thirty-nine broken staybolts. After drilling and testing under water pressure these were all found broken — and in addition to these we found fifty-nine others broken which the inspector was unable to detect by the hammer test. This surprising result led me to examine the broken staybolts critically, and I find that those detected by the hammer test were broken entirely off, while those found by drilling holes in the ends were only partially broken off.

After testing the staybolts in twelve fire boxes and finding the ratio of broken staybolts and partially broken staybolts about the same as in the first fire box tested, I concluded to try the method of testing under boiler pressure and having a helper hold on while the inspector gave the hammer test, but with no better results.

I desire now to direct your particular attention to the thirteenth and last fire box tested for broken and partially broken staybolts by the two methods. I consider it the most severe comparative test of all, from the fact that three inspectors in turn did their level best to locate broken and partially broken staybolts by the hammer test; they having been informed that the staybolts were to be drilled after they were through with their inspection. They were given all the time they required to make a careful and accurate inspection. The result was that the hammer test located four broken staybolts, and the drilling test discovered forty-six partially broken.

A careful record of the broken and partially broken bolts detected in thirteen engines shows that 440 were discovered by the hammer test and 619 by the drilling test.

To me these facts are conclusive evidence that partially broken staybolts cannot be detected by the hammer test, and I believe a great risk is run by either not drilling the ends or not using hollow staybolts, and that either of these precautions will prevent many boiler explosions with the usual verdict of "Cause of explosion unknown."

There have been more boiler explosions in recent years caused by broken staybolts than ever before. I attribute this to the fact that a much higher pressure is carried. Too great precaution cannot be taken to prevent loss of life and destruction of property, and my experience leads me to recommend that every staybolt used should be either hollow or drilled — making it self-detecting.

The expense of the precautions here recommended should not stand in the way of preventing boiler explosions due to defective staybolts, as the cost for drilling is only about $3.75 for a fire box containing 900 staybolts. I figure that the cost is only an apparent one. For example: If the 619 partially broken staybolts had not been drilled and tested in the thirteen fire boxes referred to above, these partially broken staybolts in time would have become broken staybolts and the engines containing them would have had to be laid up — possibly when needed badly — for the removal of broken staybolts, which would have necessitated the removal of jackets, air brakes, pumps, frame angle iron, and other parts covering the staybolts, thus causing an additional expense over that, if properly attended to in the shop while undergoing repairs.

It is my practice to turn engines out of shop with staybolts beyond suspicion, and I find that I have no trouble with them afterward. I recommend to such members of the Association as do not use hollow or drilled staybolts that they drill the staybolts in a few fire boxes as described, and keep a record of the number found by the hammer test and by drilling them, and I am sure that they will be surprised at the results.

MR. HERR: I would like to ask if all the broken staybolts were discovered by the inspectors?

MR. LAWES: Yes, sir.

MR. WEST: I would like to warn the members against relying entirely on these drilled tests. It is all right to detect staybolts that are broken before they are drilled. We had four engines carrying very high pressure fitted with hollow staybolts, something over 2,000 bolts, and we paid $600 additional to have the hollow staybolts put in. We relied a good deal on the hollow staybolts to detect the breaks, but we found it was not a safe reliance. I do not wish to be understood as not favoring hollow or drilled staybolts, but too much confidence should not be placed in these holes, as they are liable to become stopped up, and I do not believe too many precautions can be taken to detect broken or cracked staybolts.

MR. MACKENZIE: We have not been in the habit of drilling staybolts on our road and we do not rely on bolts that are drilled. I think there is a feature that is far better than drilling the staybolts and that is to increase your water space. Some three years ago we built four boilers and we gave them an 8½-inch water space, taking out ten flues and utilizing that part for water space and making the staybolts 8½ inches between sheets. Up to this time we have not had a broken staybolt in any of those engines. The first engine we sent out has made something like 260,000 miles.

MR. MCINTOSH: While Mr. Mackenzie's remedy would be all right when we are building new locomotives, still it would not take care of the old ones that we have in service. I want to say that I unqualifiedly approve of the process described by Mr. Lawes, that is, to drill the bolts. In my experience in drilling staybolts, extending over nearly ten years, I have found it a very reliable method, much more so than any other that I know of. It is possible that a bolt could break that is drilled, and that the hole may be filled up with mud, and no reasonable inspection will show that fact to exist. I would not advise depending entirely on the drilled staybolts, but drill the bolts and then make reasonable inspection and you will have the best results that can be obtained.

Mr. West: I would like to ask Mr. Vauclain what results are had from staybolts reduced in the center. I noticed in one of the mechanical papers that they turned out some locomotives with staybolts reduced in the center.

Mr. Vauclain: I do not know that I can say much in that direction, as we do not use the locomotives. It is from one year to half a dozen after they go out when the bolts commence to break. We not only reduce the centers of staybolts, but we drill holes into them through the outer sheet.

Mr. Leeds: I do not really believe that Mr. Vauclain and the Baldwin Locomotive Works believe in drilling staybolts, from the fact that my specifications called for the alternate staybolts to be drilled, and they asked for permission to drill them all.

Mr. Vauclain: I think, Mr. President, that we should exercise every precaution in the matter of detecting broken staybolts, and we therefore ask the permission from our customers to drill all staybolts, and we desire to do that unless they have objections to it.

The President: The hour has expired under the By-Laws for topical discussions, and we should return to the consideration of committee reports unless you otherwise direct. Is it your desire to take up another topical discussion ?

Mr. Vauclain: I move that we proceed to the regular order of business.

The President: It does not require any motion. We will resume the consideration of committee reports. The next is Committee No. 6 : " Best Metal for Cylinders, Valves and Valve Seats—What kind of metal, hard, medium or soft, should be used in locomotive cylinders, valve seats, and valves? Should the metal for valve seats and valves be the same, or different?" There seems to be no member of the committee present, and if agreeable to you the Secretary will please read the concluding recommendations of the report.

Mr. Cloud read the recommendations at the end of the report. The report is as follows:

REPORT OF THE COMMITTEE ON BEST METAL FOR CYLINDERS, VALVES AND VALVE SEATS.

To the Members of the American Railway Master Mechanics' Association :

Your committee appointed to investigate the subject of metal for cylinders, valves and valve seats, begs leave to report as follows:

The wording of the subject on which the committee was appointed reads: "What kind of metal — hard, medium or soft — should be used in locomotive cylinder valve seats and valves? Should the metal for valve seats and valves be the same or different?"

The subject involves two considerations, one being the strength of material in a casting of the shape of a locomotive cylinder; the other is the question of friction between lubricated surfaces.

The question of the strength of locomotive cylinders is an extremely complicated one. It would be possibly more correct to define this as a question of the liability of locomotive cylinders to break in service. The tendency of a cylinder to break is only partially dependent upon the strength of the material of which it is composed. The form, the pattern and the shrinkage of the material from which the casting is made are the points upon which the tendency to breakage most largely depends. As to the form of the pattern, it is almost unnecessary to state that all angles, external or internal, should be carefully avoided. This is especially true of internal angles, which in every case should be replaced by fillets of generous radius. Also the pattern should be so constructed that the various walls and partitions are practically of uniform thickness, or in other words, that all parts of the casting may cool, and consequently shrink, at a uniform rate. If, when a cylinder casting is cold, it has no strain in any part from unequal contraction of the different parts, it will not be liable to crack in service. Unfortunately, however, owing to the extremely complicated form of the casting, such strains always do exist, even when the highest skill is used in proportioning the parts. Owing to the fact that strains from shrinkage cannot be entirely avoided, the question of the shrinkage of the metal from which the casting is made becomes of paramount importance. It will readily be admitted that if the metal in the cylinder shrinks one-sixteenth of an inch to the foot in cooling, the internal strains will be much less than if the metal used should shrink one-eighth of an inch to the foot. It is, therefore, of the utmost importance that the metal selected for cylinders should show the least possible amount of shrinkage. The various kinds of pig iron differ materially in this respect, and in the same brand of pig iron the amount of shrinkage varies materially with the grade of the iron, the rule being that the higher the grade or the harder the iron, the greater will be the shrinkage of the casting made therefrom.

An expert in the matter of pig iron can readily pick out the harder or softer iron of a given brand by the difference in the shrinkage, as shown on the top face of the pig, the harder iron always showing the greater amount of shrinkage. If, therefore, we are simply interested in obtaining a cylinder with the least amount of shrinkage in the material, and consequently with the smallest amount of internal strain, we should select the soft metal. It is, however, a fact that in cast iron the ultimate strength of the same increases with its hardness, so that with the same brand of iron the softest metal will show the least strength on the testing machine, and the test show an increase in strength with the hardness of the metal until the point is reached at which it becomes brittle. The point at which the excessive brittleness is reached represents a pig which would be much too hard to use in cylinders, as a cylinder casting could not be made of such material owing to the fact that the excessive shrinkage would cause the same to crack in cooling.

As will be seen from the above, it is necessary to consider the question of hardness directly in connection with that of shrinkage. The metal composing the cylinder must be soft enough so that the boring and planing operations can be properly performed. The easiest and most accurate way of determining the hardness of a metal is to pour from the metal, when molten, a chill test — that is, to pour a small casting so that a portion of the casting is formed against an iron chill. Unless iron is extremely soft there will be found on breaking the casting a certain depth of white iron formed against the chill, and the depth of this white iron will vary directly as the hardness of the metal from which the casting is made. If a casting is made from a metal for which the chill test shows a depth of about one-half inch of white iron, the casting can be comfortably worked on the planer and boring machine. If, however, the chill test shows a depth of three-fourths of an inch white iron, it can be worked with considerable difficulty, although when wheels are made with a metal of this hardness, or even harder, they can be bored with reasonable facility. This, however, depends also upon the brand of metal which is used. With certain mixtures of iron, a chill test showing one-half inch will indicate a casting which is very difficult to work; but without going into these fine details, a chill test of one-half inch white iron will give a casting, which in the shape of a cylinder can be satisfactorily put through the ordinary machining operations.

If the iron chills materially deeper than this, the difficulty of machining will be so great as to condemn the casting. Even if the casting could be machined the excessive shrinkage of such hard metal would cause serious trouble from cracking of the cylinders in service.

When we consider the question of friction, both in the case of the cylinder itself and the valve seat, there seems to be no reason to hesitate in saying that the harder the wearing surfaces the better the results, both as to wear and frictional resistance. This is undoubtedly true within the limits of a cylinder casting, and is possibly true within any limit. The problem, therefore, in the case of a cylinder composed of one piece narrows itself down to that of providing the hardest possible cylinder consistent with the necessary freedom from breakage, and with machining requirements.

In the matter of mixtures of iron for cylinders, the accompanying statement gives a summary of replies received from members of this Association. As to hardness, those who specify uniformly require the casting to be as hard as can be worked, with the exception of two who require that the mixture shall chill ½ inch.

REPORTS FROM MEMBERS ON CYLINDER MIXTURES.

ROAD.	Charcoal Iron.	Coke Iron.	Car Wheel Scrap.	Soft Scrap.	Scotch Pig.	Steel.	Tensile Strength.	Chill.
	%	%	%	%	%	%	lbs.	
Fall Brook	25	25	50	......	......	......	......	......
Can. Pac	......	......	33½	33⅓	33⅓	......	......	......
B. & O	......	No. 2. 33⅓	33⅓	33⅓	......	......	30,300	......
L. V	......	50	......	50	......	......	......	......
U. P.	35	......	35	30	......	......	......	½ in.
N. & W.	......	No. 2. 20	......	60	......	20	......	⅛ in.
B. & O. S.-W.	31	......	31	38	......	......	......	......
So. Pac	......	33⅓	33⅓	33⅓	......	......	......	......
L. & N	25	......	75	......	......	......	......	......
D. L. & W	25	50	......	25	......	......	......	......
L. S. & M. S	50	......	......	50	......	......	......	......
C. M. & St. P.	50	......	50	......	......	......	......	½ in.

It is believed by your committee that the chill test described above is an accurate indication of the hardness of the iron, and that ½-inch depth of white iron, or, as it is generally expressed, a "half-inch chill," represents the extreme of hardness permissible in a cylinder casting. The C. M. & St. P. R'y has had thirty engines, 160 pounds pressure, in service for about five years with the mixture and hardness as shown in this summary, and up to the present time have had seven cylinders cracked, the average mileage being 157,000 miles, the failures in every case being due to shrinkage cracks and not to breakage. This would indicate that the hardness as given, ½-inch chill, is drawing close to the practical limit.

A shrinkage test could be made by casting a square bar 1½ inch in cross-section and 2 feet long, casting the ends of this bar against iron chills placed accurately 2 feet apart. The length of the bar, when cold, will represent the shrinkage tendency of the mixture used. This test should always be made in combination with the chill test, as the same iron will show less shrinkage when chilling ¼ inch than when chilling ½ inch.

Several of the members specify by name the brands of pig iron used. Their recommendations in this respect are as follows:

The L. & N. specify 25 per cent No. 1 Bellefonte charcoal C. B. iron.

The Southern Pacific specify 33⅓ per cent Sloss coke iron.

The Union Pacific specifies 10 per cent Salisbury No. 2, and 25 per cent Minneapolis; both charcoal iron.

The C. M. & St. P. specifies 20 per cent Salisbury No. 2, 20 per cent Hecla No. 3, 10 per cent Pioneer No. 3; all charcoal irons.

The N. & W. reports that their mixture shrinks about one-eighth inch per foot, and that a bar two inches in cross-section and 21⅓ between supports gives a transverse strength of about 13,000 pounds.

The above, as well as the summary, shows a great variation in practice. Your committee would recommend that members who have the facilities make further tests on chill, shrinkage and strength, and, to secure uniformity, recommends dimensions as follows:

The chill test shall be 6 inches in length and 2 inches square in cross-sections, one side, 2 by 6 inches, to be cast against a smooth cast-iron chill not less than 1½ inches in thickness and 6 inches square.

The shrinkage test shall be 24 inches in length between the chills forming the ends and 1½ inches square cross-sections.

The strength shall be the shrinkage test above described.

There would be no difficulty in arranging a flask that would contain the castings described above, so that the chill tests, the shrinkage tests and the strength test could all be poured from one ladle of molten metal. A series of tests of this kind made for each cylinder cast, supplemented by chemical analyses to determine, if possible, the chemical peculiarities that cause one iron to shrink more than another when chilling the same would go far toward putting the question of the most suitable iron for cylinder castings on a firm and definite basis.

In the matter of metal for valve seats, the question is — "Should the metal for valve seats be the same or different?"

A number of tests have been made of brass slide valves, and so far as your committee have been able to ascertain, the results have been unsatisfactory as compared to cast iron, both as to frictional resistance and wear. Your committee cannot do better on this point than to quote from Joshua Rose as follows: "Cast iron in some situations is far more durable than hardened steel; thus when surrounded by steam it will wear better than will any other metal. Thus, for instance, experience has demonstrated that piston rings of cast iron will wear as smoothly, better and equally as long as those of steel, and longer than those of either wrought iron or brass, whether the cylinder in which it works be composed of brass, steel, wrought iron or cast iron; the latter being the most noteworthy, since two surfaces of the same metal do not, as a rule, wear or work well together. So also, slide valves of brass are not found to wear so long or so smoothly as those of cast iron, let the metal of which the seating is composed be whatever it may; while, on the other hand, the cast-iron slide valve will wear longer of itself and cause less wear to its seat, if the latter is of cast iron, than if of steel, wrought iron, or brass."

If greater hardness is desired in the wearing part of the cylinder and valve seats than is consistent with the strength of the body of the cylinder, the same can be secured by the use of bushings and false valve seats, and this course is recommended by a number of members.

In conclusion, your committee recommends:

1. That as a rule, cylinders should be as hard as is consistent with machining requirements.

2. That the matter of shrinkage should receive close attention in making cylinder mixtures.

3. That members having the facilities should make systematic tests of the hardness, shrinkage and strength of metal used in cylinder castings and supplement the same with chemical analyses.

4. That valves should be of cast iron.

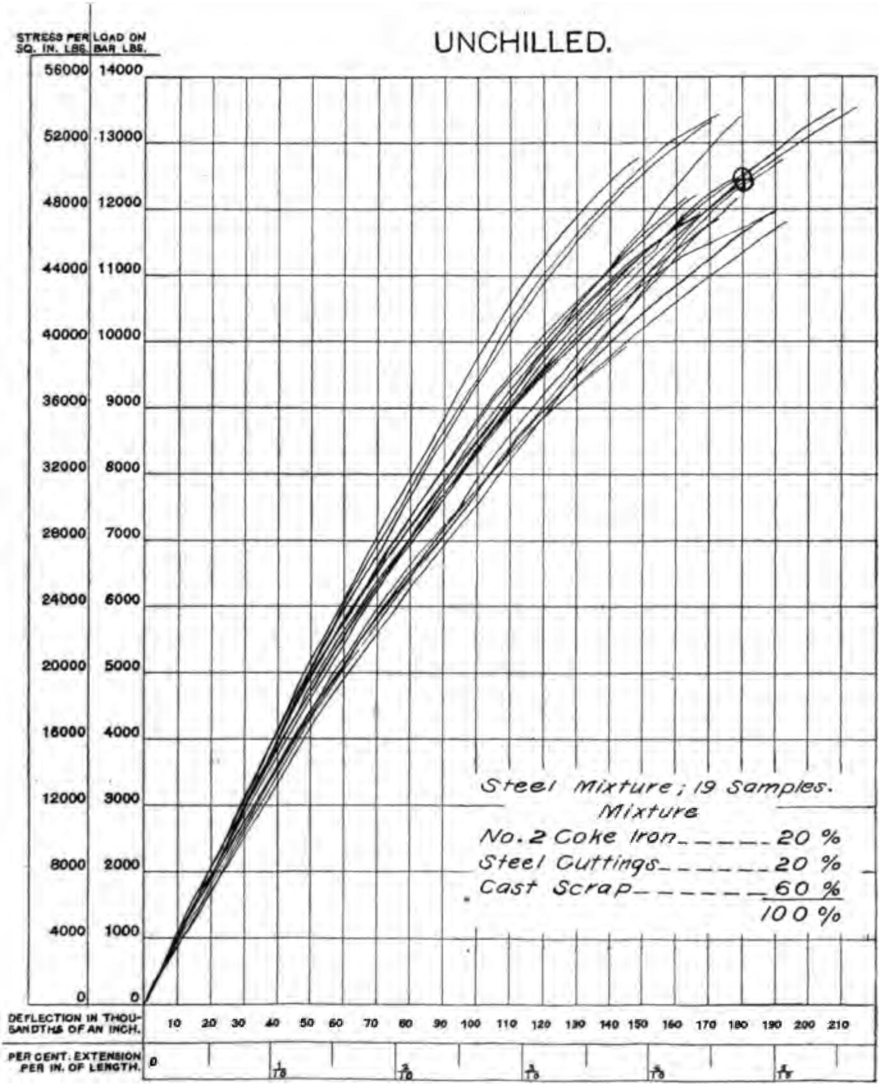
J. N. Barr, Chairman,
G. F. Wilson,
G. W. Stevens,
F. W. Morse,
H. Tandy,
Committee.

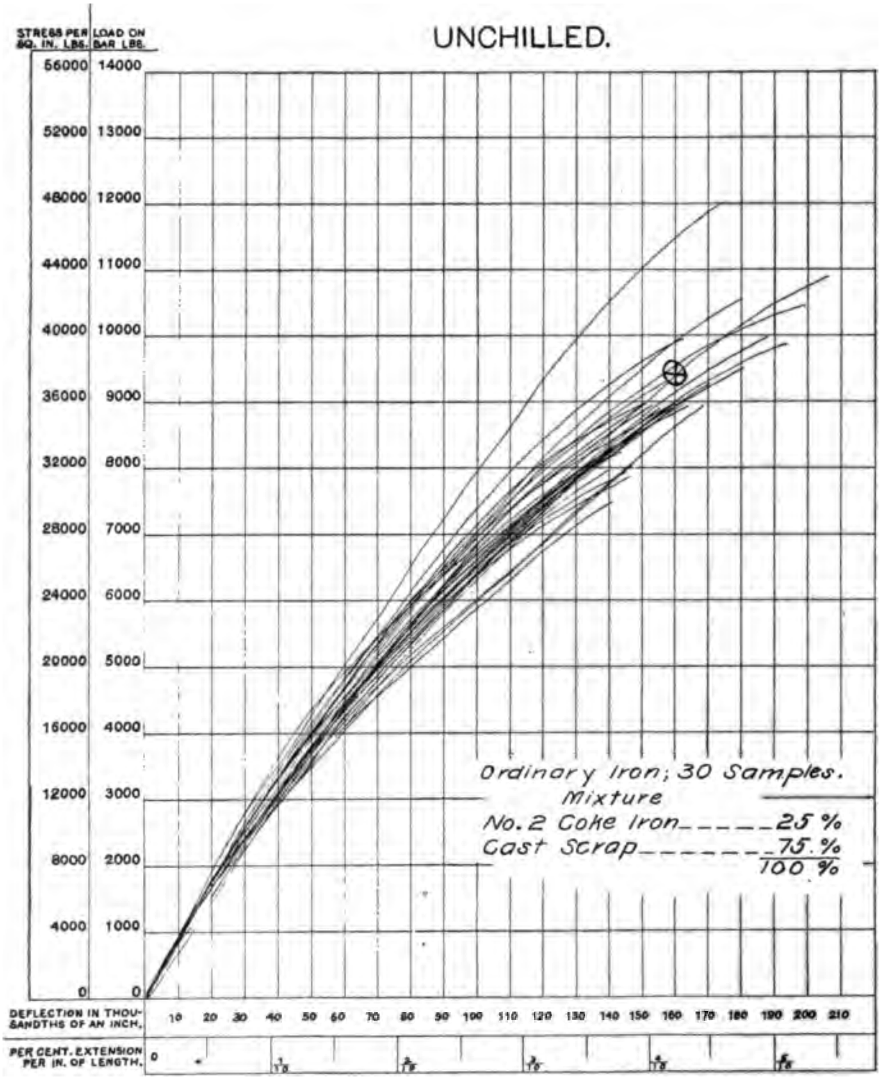
The President: What is your pleasure in reference to this report?

On motion of Mr. Sprague the report was received.

The President: The report is open to discussion.

Mr. Henderson: Mr. President, as the report states that the Norfolk & Western Railway is the sole one using a mixture containing steel in cylinders, I have a few notes which I prepared which I thought might be of interest to some of the members. The steel mixture consists of 20 per cent of steel—old springs, any old spring scrap, boiler scrap and material of that sort. No steel castings, however, have been used. Also 20 per cent of No. 2 coke iron and about 60 per cent of scrap, and the metal shows a slight chill. Here is a sample [exhibiting a sample] which shows barely one-eighth of an inch chill, and also shows how the metal will polish up. One effect seems to be that we get a very good solid metal in cylinder castings. It seems to show less trouble from honeycombing and the metal is much more solid and finishes up much more nicely than the ordinary cast-iron mixture. I submit herewith some diagrams showing some curves which have been plotted showing the results of tests for two months on nineteen samples of this steel mixture by which it can be seen how regular the mixture runs. On these curves the height represents the load and the abscissæ represent the deflection. This mixture shows very regular results and is also twenty per cent stronger than the ordinary cast-iron mixture. The analysis of the sample is as follows: Silicon, 1.51; manganese, .33; phosphorus, .65; sulphur, .068; combined carbon, .62; graphite, 2.45. These samples I will turn over to the Secretary.


UNCHILLED.
STRESS PER SQ. IN. LBS.
LOAD ON BAR LBS.
56000 14000
52000 13000
48000 12000
44000 11000
40000 10000
36000 9000
32000 8000
28000 7000
24000 6000
20000 5000
16000 4000
12000 3000
8000 2000
4000 1000
0 0
DEFLECTION IN THOUSANDTHS OF AN INCH.
10 20 30 40 50 60 70 80 90 100 110 120 130 140 150 160 170 180 190 200 210
PER CENT. EXTENSION PER IN. OF LENGTH.
0 1/10 2/10 3/10 4/10 5/10
Steel Mixture; 19 Samples.
Mixture
No. 2 Coke Iron ..... 20 %
Steel Cuttings ..... 20 %
Cast Scrap ..... 60 %
100 %


UNCHILLED.
STRESS PER SQ. IN. LBS.
LOAD ON BAR LBS.
56000 14000
52000 13000
48000 12000
44000 11000
40000 10000
36000 9000
32000 8000
28000 7000
24000 6000
20000 5000
16000 4000
12000 3000
8000 2000
4000 1000
0 0
DEFLECTION IN THOUSANDTHS OF AN INCH.
10 20 30 40 50 60 70 80 90 100 110 120 130 140 150 160 170 180 190 200 210
PER CENT. EXTENSION PER IN. OF LENGTH.
0 1/10 2/10 3/10 4/10 5/10
Ordinary Iron; 30 Samples.
Mixture
No. 2 Coke Iron 25 %
Cast Scrap 75 %
100 %

Mr. McIntosh: Mr. Chairman, there is considerable difficulty experienced in getting cylinders strong enough to stand the strains that they are subjected to, especially in the saddle, with our boilers raised to a high center of gravity. It occurs to me that it should be possible, with modern improvements in the way of making steel castings, to cast the cylinders of steel entirely and bush them and put on false valve seats. I have no experience in that direction, and have not heard of its being done; but it would seem that it is possible to do so. That would give a great deal stronger saddle.

Mr. Leeds: I would like to ask Mr. Henderson if he has ever made a chemical test from different specimens taken from the same heat. I have always found in foundry practice that there was a liability and a very strong one, unless the scrap and the pig were very nearly the same size when put into the cupola, to get several different kinds of iron from the same charge, and it seems to me that in the melting of steel, unless it was mechanically mixed after leaving the cupola by pouring from one ladle to another, that there was a possibility of getting a very streaky result.

Mr. Henderson: I would say, in answer to that question, that there has not been an analysis made of many heats. One reason is that very often the steel heat constitutes only one tap from the cupola during the whole day's output. They generally put the steel mixture in so as to come down about on the fourth charge. After 370 pounds of coke is put in, they put in about 70 pounds of limestone, then 800 pounds of steel scrap, in fairly large pieces, such as old draft springs, bolster springs and things of that sort; then 800 pounds of pig iron; then 2,400 pounds of cast scrap. Then it repeats with coke, and the next will be either a steel charge or a plain charge. There are two test bars made upon the same tap. One is a chilled bar and the other an unchilled bar. So, answering your question, there is very often only one tap of the steel mixture during the day's heat.

Mr. Vauclain: If you would permit me the time, I would read you a short paper in this matter which was sent to Mr. Barr, but unfortunately arrived too late to be incorporated in the report. It was in the form of a letter to him:

During the last two years we have been thoroughly investigating the character of the iron best adapted for use in cylinders and valves. After a carefully conducted and elaborate series of tests we settled upon the composition having the desired physical properties, and then calculated the cupola charges, disregarding entirely the brands or furnace grading of the irons, using our tests of the car, together with our knowledge of the losses that occur in melting as the basis of such calculations. The first step was to adopt some systematic record. We therefore entered the exact weight of the various kinds of iron, of coke and of flux that composed each charge on one side of a folio page. A standard test piece was taken from each tap, and the results of all tests entered on the opposite page. The tensile and subsequently the transverse tests with the chemical analysis were made regularly; shrinkage, chill and abrasion tests were made when it was deemed necessary. The tensile tests are cast in 1¼-inch cylinders and turned down to ⅝-inch taper section, and pulled in ball and socket shackles; the transverse tests are inch square, tested in rough section.

It was early shown that in order to have castings of uniform quality considerable care must be used in charging the cupola, the irons composing the different charges must be thoroughly mixed, otherwise the small pieces of metal or that having a low melting point will be first melted down, giving castings of entirely different characteristics from the same charge. Over ten thousand tests have been made in all, and while all the results have not as yet been systematically tabulated with a view of establishing a relation between the physical and chemical properties of cast iron, we have gone far enough to remove all doubt of the existence of such a relation. There is also quite a definite relation between the strength of the iron and the wearing properties, but it is wrong to assume that the harder the iron the better the wearing qualities. The shrinkage of an iron is generally assumed to increase with the strength, but this is not true with a properly mixed iron, for we can regularly run irons up to 32,000 or 33,000 pounds without increasing the shrinkage; on the other hand, the iron that gave us the greatest trouble from shrinkage was an extremely soft, low tensile iron, 18,000 pounds. Our experience indicates that with proper composition an iron can have as high a tensile as 35,000 pounds, without danger of the cylinder cracking. The tendency to crack bears a more definite relation to the shrinkage than to the hardness.

Regarding the tests in detail, perhaps the most interesting are the abrasion or wearing tests. The specimen, a cylinder ⅝-inch diameter 1 inch high, was turned from the broken tension tests. These were carefully weighed and the loss in weight noted, after test. The test consisted in weighing the cylinder and abrading it by rubbing in contact with a hardened steel die. The results of a number of samples are graphically shown in Diagram 1. It will be noted that up to 28,000 pounds the wear decreases rapidly as the tensile increases. The best wearing material ranged in tensile strength from 28,000 to 32,000 pounds per square inch, but within these limits a given decrease in strength did not show a proportionate increase in wearing qualities, as shown in Diagram 2.

Regarding the chemical properties, there are, perhaps, more misconceptions concerning sulphur than any other element. Any defects that develop are invariably attributed to sulphur. We, however, found that an iron is undesirable for use in cylinders unless it contains a minimum of .07 per cent, and that it really exerts beneficial results up to .12 per cent. The difficulties of getting a perfect casting from such a complicated mold as a locomotive cylinder increases when the sulphur runs above .15 per cent, and the tendency to crack is also greater. A large part of the sulphur in cast iron is derived from the fuel, so that to keep this element within limits it is really more essential to watch the coke and working of the cupola than the pig iron. Generally speaking, sulphur increases the tensile strength by increasing the solubility

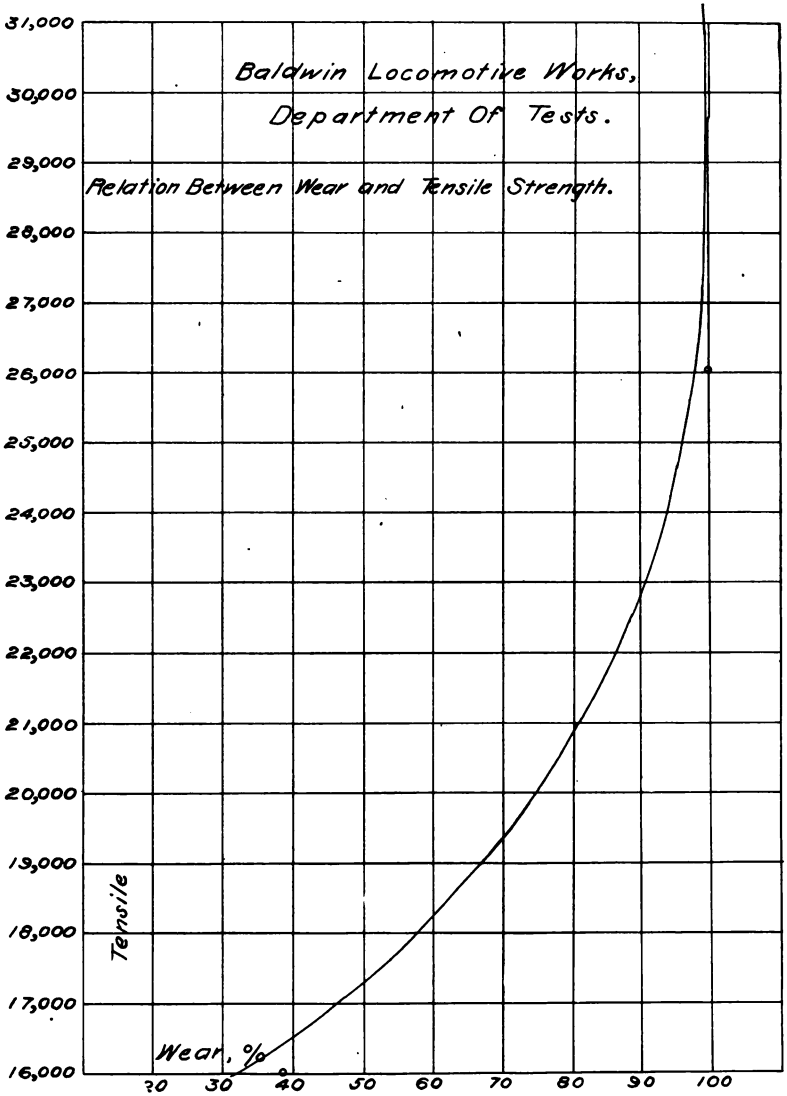

Baldwin Locomotive Works,
Department Of Tests.
Relation Between Wear and Tensile Strength.
31,000
30,000
29,000
28,000
27,000
26,000
25,000
24,000
23,000
22,000
21,000
20,000
19,000
18,000
17,000
16,000
Tensile
Wear, %
20
30
40
50
60
70
80
90
100

Diagram No. 1.

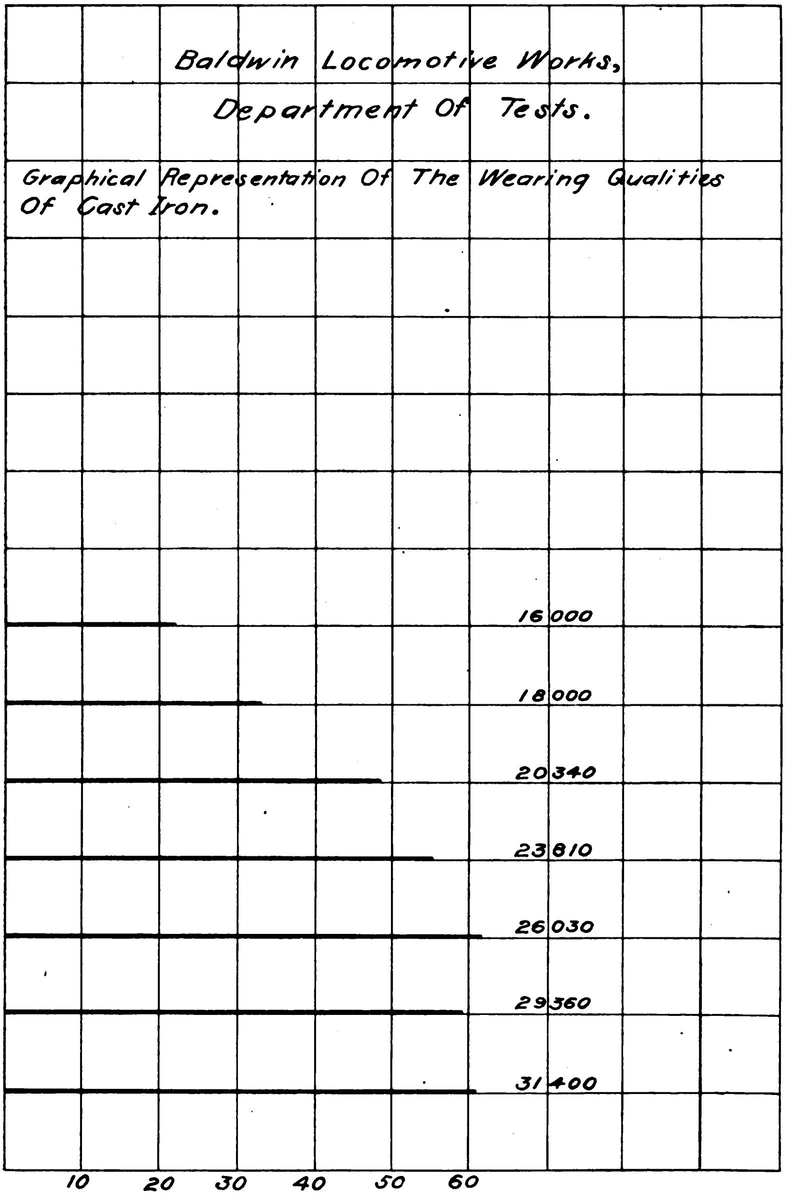

Baldwin Locomotive Works,
Department Of Tests.
Graphical Representation Of The Wearing Qualities Of Cast Iron.
16000
18000
20340
23810
26030
29360
31400
10
20
30
40
50
60

Diagram No. 2.

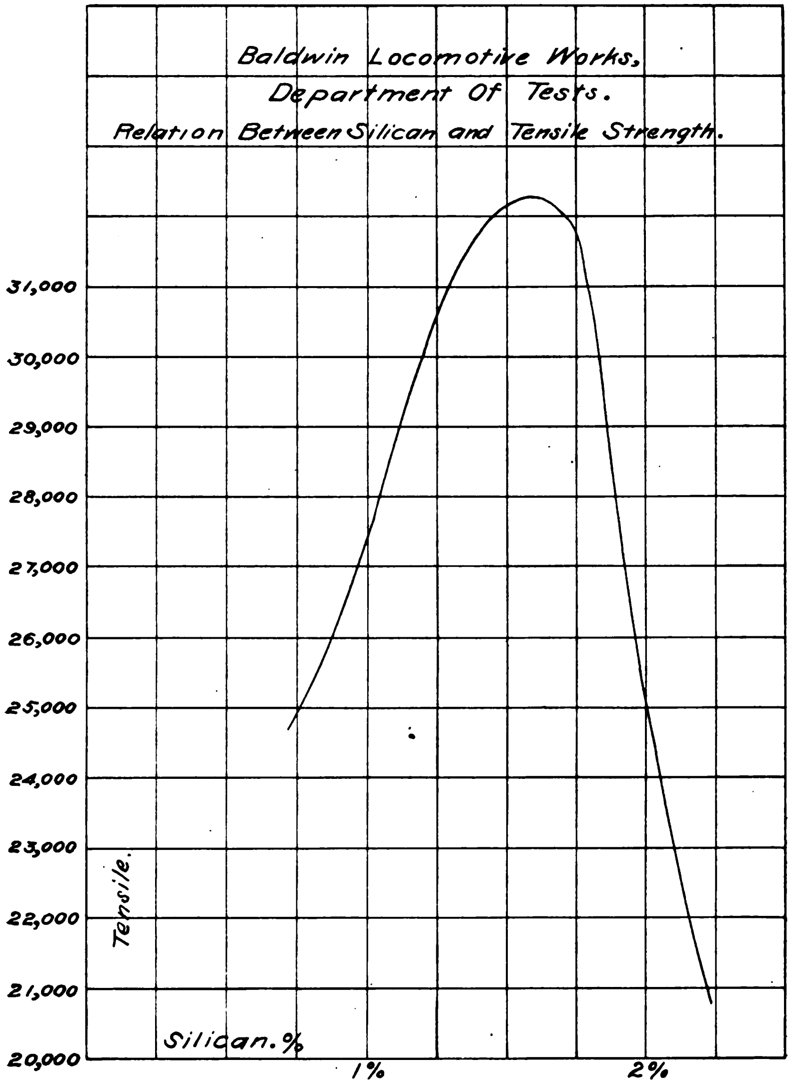

Baldwin Locomotive Works,
Department Of Tests.
Relation Between Silican and Tensile Strength.
31,000
30,000
29,000
28,000
27,000
26,000
25,000
24,000
23,000
22,000
21,000
20,000
Tensile.
Silican. %
1%
2%

Diagram No. 3.

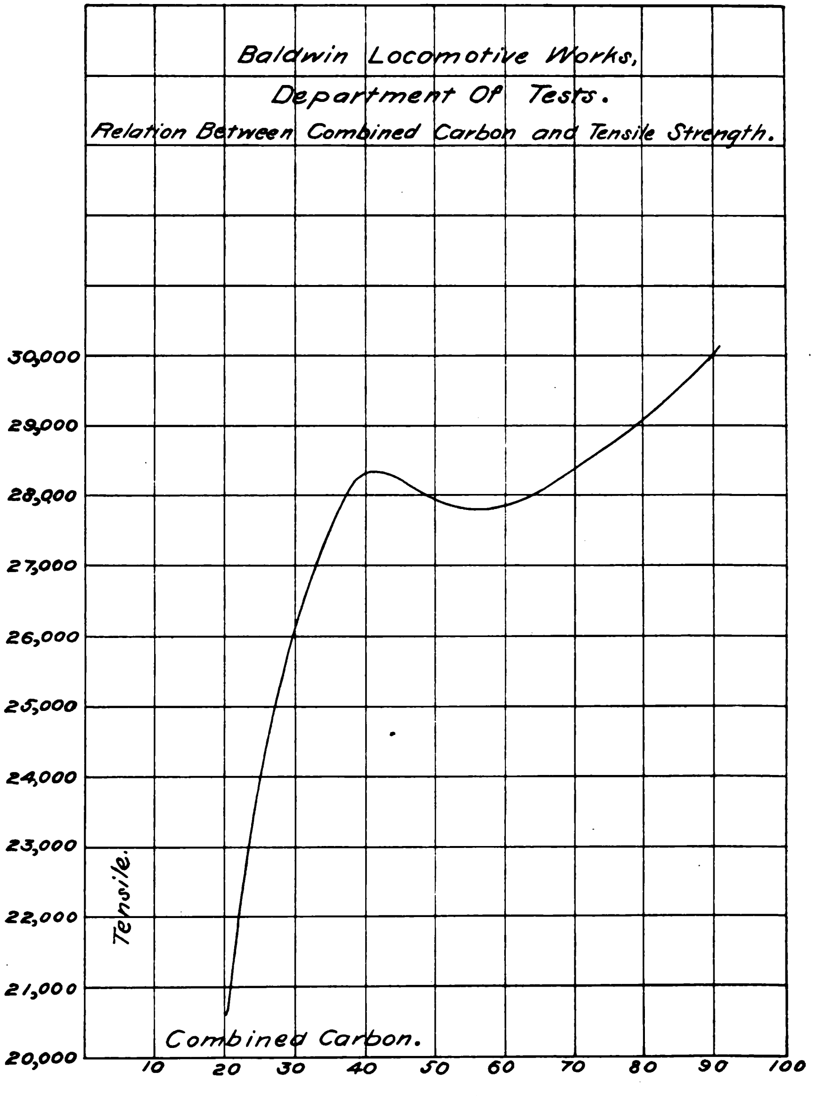

Baldwin Locomotive Works,
Department Of Tests.
Relation Between Combined Carbon and Tensile Strength.
30,000
29,000
28,000
27,000
26,000
25,000
24,000
23,000
22,000
21,000
20,000
Tensile.
Combined Carbon.
10
20
30
40
50
60
70
80
90
100

Diagram No. 4.

of the graphite in the iron, though our data is not yet in shape to give quantitative results. Silicon, as is well known, acts as a softener, and we aim to secure a silicon of from 1.3 per cent to 1.7 per cent in our cylinder mixtures. The influence of silicon on the tensile strength is shown in Diagram 3. Phosphorus and manganese both act as hardeners, and if present in too large amounts, make the iron brittle; they both tend to give the finished casting a good, clean, light color, and when below .8 can do no harm. Our experience has been chiefly with low manganese irons, for during the process of melting the principal parts of the manganese seemed to become oxidized so that the casting rarely contained more than .4 per cent.

We, therefore, aim to have our cylinder mixtures conform to the following specification:

Tensile	27,000 to 33,000	pounds.
Combined carbon, about	.6	per cent.
Manganese, about	.35	"
Phosphorus	.6 to .9	"
Sulphur	.07 to .12	"

Our pig irons being so mixed in charging that the mixture would supply that element which would otherwise be lacking.

To show the uniformity of the product if proper care is observed, the following tests are taken from our records; in no two instances was the kind of iron used in making up the mixtures:

	Tensile.	Carbon.	Manganese.	Phosphorus.	Sulphur.	Silicon.
1	35,960	.52	.35	.63	.11	1.47
2	30,900	.51	.34	.57	.10	1.62
3	30,130	.51	.33	.75	.10	1.49
4	28,310	.50	.35	.83	.07	1.50
5	31,390	.54	.36	.74	.08	1.41
6	31,800	.60	.32	.65	.10	1.44
7	32,700	.62	.35	.59	.12	1.52
8	30,530	.50	.32	.49	.12	1.35
9	31,110	.63	.34	.59	.12	1.41

Tests 8 and 9 contain more than 50 per cent of an iron which, when used alone, gave exceedingly brittle, soft and dirty cylinders, but when judiciously mixed with other irons gave exceptionally good results. Incidents such as these — and this is not the only case of its kind — lead us to believe that there is little in the claims that certain brands of pig iron possess special characteristics. There is no doubt but that the same qualities can be had by properly blending different grades to get the desired iron for the work at hand. The mixture of charcoal and ordinary pig iron give exceptionally good wearing irons, but cylinders cast with such mixtures are quite apt to crack. The same can be said of cold blast iron.

I wish to add further that I brought one or two samples of this iron with me in the shape of thin plates of a quarter of an inch thick, which, after they were cast, I took to the boiler shop and put them under an ordinary boiler punch and punched holes in the two plates without their showing any sign of fracture.

MR. HENDERSON: I would like to move that the document Mr. Vauclain read be embodied in the minutes.

The motion was carried.

MR. VAUCLAIN: I move that we bring up the consideration of Subject No. 8.

The motion was carried.

Mr. Henderson, the chairman of the committee on this subject, presented the following report:

To the President and Members of the Master Mechanics' Association:

The proper ratio of heating surface and grate area to cylinder volume for passenger and freight engines, whether burning anthracite or bituminous coal, and the ratio which should exist between the size of cylinder and length of steam port, were the problems given to this committee, which soon found that the report, if properly presented, would require much work and study, as well as assistance from various members of the Association in the way of furnishing information. A circular of inquiry was promptly sent out, which would enable your committee, if answered, to make comparisons between these engines, operating under different conditions, which were known to give satisfactory steaming results, and those which did not. It was however decided, that if the proper reliable data could be secured, it would be extremely valuable to introduce an analytical determination of the points in question, and to compare this with the practical results as given by the answers to the circular. As the times did not seem propitious to request anyone to make experiments for this purpose, it was decided to confine ourselves to the results of such tests as had already been made by reliable parties, if we could obtain the necessary information through such channels. Many personal letters were written to roads (both American and European) who were known or supposed to have the desired records, but such few responses were secured that your committee was compelled to depend almost entirely upon its own resources and the very meager information at its disposal, and therefore makes this explanation in order to forestall any criticisms (just or unjust) relative to the fact that an elaborate superstructure had been built upon an insufficient and weak foundation.

In order to present an analytical discussion of the question, it was necessary to determine approximately the following points:

1. The force necessary to move a train of a given weight at various speeds and accelerations over various grades and curves.

2. The ratio of mean effective pressure in the cylinders to initial pressure, for various speeds, cut-offs and lengths of steam port.

3. The ratio of cut-off pressure to initial pressure for various speeds, cut-offs and length of steam port.

4. The evaporative value of different fuels at various rates of combustion per square foot of heating surface.

5. The evaporative value of different fuels at various rates of combustion per square foot of grate area.

It will be at once recognized, that if we are able to satisfactorily determine these various points, the proper heating surface and grate area needed by a locomotive for doing a definite amount of work can be readily calculated.

The solution of these requirements gave your committee the greatest amount of work.

First, considering the subject of Train Resistance. After much research it was decided that the resistance due to speed was perhaps best represented by the formula published in *Engineering News*, of June 9, 1892, which is:

$$y_1 = \frac{S}{4} + 2,$$

where y_1 = resistance in pounds per net ton of load,
S = speed in miles per hour.

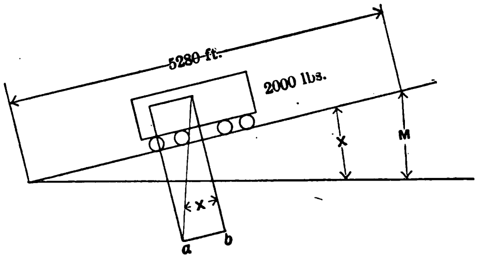
The force for starting is, however, about 20 pounds per ton, which falls to 5 pounds as soon as a low rate of speed is reached.

The resistance due to grades is expressed by

$$y_2 = 0.38\,M,$$

where y_2 = resistance in pounds per net ton of load,
M = grade in feet per mile.

Consider a load of a ton of 2,000 pounds on a grade of "M" feet per mile, as in the figure.



The component of the load acting in the line of traction, or parallel to the track, is $a\,b$ or 2,000 sin X; but

$$\sin X = \frac{M}{5{,}280} \;\therefore\; a\,b = \frac{2{,}000\,M}{5{,}280} = 0.38\,M.$$

The resistance due to curves is generally taken at from 0.5 to 0.7 pounds per ton per degree of curvature. Selecting the latter value, and assuming that locomotives, on account of their long rigid wheel base, produce double the resistance of cars, we have

$$y_3 = 0.7\,C \text{ for cars,}$$
$$= 1.4\,C \text{ for locomotives,}$$

where y_3 = resistance in pounds per net ton of load,
C = curvature in degrees.

It may also be desirable to consider the resistance due to acceleration of the speed of the train, and it is found that this can be expressed by the formula

$$y_4 = 0.0132\, V^2$$

where y_4 = resistance in pounds per net ton of load,

V = speed attained in one mile, expressed in miles per hour, starting from rest.

Let S = space in feet,

v = velocity in feet per second,

p = acceleration in feet per second,

P = force producing acceleration, in pounds,

G = weight of body in pounds,

g = 32.2, acceleration of gravity;

then

$$S = \frac{v^2}{2p}, \text{ and } p = \frac{Pg}{G}, \therefore S = \frac{v^2 G}{2Pg}, \text{ and } P = \frac{v^2 G}{2Sg}$$

Substituting the proper values, and introducing a coefficient to express speed in miles per hour, we have

$$y_4 = \frac{2.15\, V^2 \times 2{,}000}{2 \times 5{,}280 \times 32.2} = 0.0126\, V^2.$$

This considers a motion of translation only. In order to allow for the rotative inertia of wheels and axles, let us consider a car weighing 60,000 pounds with four pairs of wheels and axles.

2 wheels, 36 inches diameter,	@ 700 pounds each	=	1,400 pounds
1 axle	@ 450 "	=	450 "
	Total weight	=	1,850 "

The moment of inertia of a cylinder =

$$\tfrac{1}{2} M r^2 = \frac{G r^2}{2g}$$

where M = mass of body = $\dfrac{G}{g}$

r = radius of cylinder; therefore

moment of inertia of wheels =

$$\frac{1{,}400 \times 324}{2g} = \frac{226{,}800}{g}$$

moment of inertia of axle =

$$\frac{450 \times 6}{2g} = \frac{1{,}350}{g}$$

moment of inertia of 2 wheels and 1 axle =

$$\frac{228{,}150}{g}$$

and dividing by $18^2 = 324$,

$$\frac{228{,}150}{324\, g} = \frac{704}{g} \text{ at circumference of wheel.}$$

Rotative inertia of wheels and axle = 704 pounds, or for the four pairs of wheels and axles = 2,816 pounds. Comparing this with the weight of the car, 60,000 pounds, we have

TABLE A.

INDEX TO EVAPORATIVE VALUE OF FUELS, DIAGRAMS 4 AND 5.

No.	Location of Mine.	Kind of Fuel.	Ratio of Heating Surface to Grate Area.
1	Pennsylvania	Anthracite, large	45
2	"	" "	20
3	"	" fine	20
4	"	" "	20
5	"	Semi-Bituminous	70
6	"	"	84
7	Virginia	"	66
8	"	"	57
9	"	"	49
10	Illinois	Bituminous	50
11	"	"	55
12	"	"	71

No. 13 had a ratio of heating surface to grate area of 100, but the kind of fuel is not positively known—it probably resembled a lignite.

No. 14 represents Prof. Goss' experiments with diminishing grate areas.

Nos. 15, 16 and 17 represent the experiments of the Paris, Lyons and Mediterranean Railway, made a few years ago with various lengths of tubes, the dimensions being 10 feet, 15 feet and 20 feet, respectively.

It would appear, from a study of these diagrams, that there is a loss in efficiency of fuel by increasing the rate of combustion per square foot of grate area per hour, which is chiefly accounted for by the unburnt coal which passes out of the stack, and which loss is represented by curve 14; and a loss by increasing the rate of combustion per square foot of heating surface per hour, which is due to the fact that the gases pass over the heating surfaces more quickly, and which is partly represented by curves 15, 16 and 17. Under the conditions which exist in ordinary locomotive service, therefore, we may expect a steeper curve, occasioned by the loss in efficiency from both causes, and it will be seen that most of the curves have this increased slope.

From these diagrams it is patent that results widely apart can be obtained with the same coal, and, therefore, your committee considers that the best way to attempt to represent the value of fuels will be by zones instead of single curves. The upper portion of the zone may be taken to give the values of good grades of fuel under favorable conditions, and the lower portion when circumstances are not so favorable. This zone may be subdivided for different kinds of coal, and the diagrams show what is considered a fair division in this respect. This, of course, applies only to the proportions usually found in locomotive boilers. It would appear, from Diagram No. 4, that a poor coal might be made to yield almost as much economy as a better coal, if the rate of combustion were properly reduced. This shows that, in general, the boiler of a locomotive should be as large as possible, being limited only by the weight which is allowable and the clearances of the railroad, and that in designing a locomotive, every part should be made as light as possible, consistent with strength, and the boiler, with the water in it, should utilize every surplus pound of weight available.

In order to further facilitate calculations relating to the steam-producing and steam-using capabilities of the locomotive, the following tables and data are introduced:

TABLE B.

REVOLUTIONS PER MINUTE FOR VARIOUS DIAMETERS OF WHEELS AND SPEEDS.

Diameter of Wheel.	MILES PER HOUR.							
	10	20	30	40	50	60	70	80
50 inches	67	134	201	268	336	403	470	538
56 "	60	120	180	240	300	360	420	480
60 "	56	112	168	224	280	336	392	448
62 "	54	108	162	217	271	325	379	433
66 "	51	102	153	204	255	306	357	408
68 "	49	99	148	198	247	296	346	395
72 "	47	93	140	187	233	279	326	373
78 "	43	86	129	172	215	258	301	344
80 "	42	84	126	168	210	252	294	336
84 "	40	80	120	160	200	240	280	320
90 "	37	75	112	150	186	224	261	299

TABLE C.

PERCENTAGES OF INITIAL PRESSURE FOR VARIOUS MEAN EFFECTIVE AND CUT-OFF PRESSURES.

M. E. or C. O. Pressure.	INITIAL PRESSURES.										
	100	110	120	130	140	150	160	170	180	190	200
20	20	18	17	15	14	13	12	12	11	11	10
30	30	27	25	23	21	20	19	18	17	16	15
40	40	36	33	31	29	27	25	24	22	21	20
50	50	45	42	38	36	33	31	29	28	26	25
60	60	54	50	46	43	40	37	35	33	32	30
70	70	64	58	54	50	47	44	41	39	37	35
80	80	73	67	62	57	53	50	47	44	42	40
90	90	82	75	69	64	60	56	53	50	47	45
100	100	91	83	77	71	67	62	59	56	53	50
110	....	100	92	85	79	73	69	65	61	58	55
120	....	....	100	92	86	80	75	71	67	63	60
130	....	....	....	100	93	87	81	76	72	68	65
140	....	....	....	....	100	93	87	82	78	74	70
150	....	....	....	....	....	100	94	88	83	79	75
160	....	....	....	....	....	....	100	94	89	84	80
170	....	....	....	....	....	....	....	100	94	89	85
180	....	....	....	....	....	....	....	....	100	95	90
190	....	....	....	....	....	....	....	....	....	100	95
200	....	....	....	....	....	....	....	....	....	....	100

TABLE D.

VOLUME OF VARIOUS CYLINDERS IN CUBIC FEET.

(See end of report.)

TABLE E.

WEIGHT OF A CUBIC FOOT OF STEAM IN POUNDS, AT VARIOUS PRESSURES ABOVE THE ATMOSPHERE.

Pressure.	Weight.	Pressure.	Weight.	Pressure.	Weight.
0	0.038	70	0.198	140	0.348
10	0.063	80	0.219	150	0.370
20	0.086	90	0.241	160	0.390
30	0.109	100	0.263	170	0.411
40	0.131	110	0.284	180	0.432
50	0.154	120	0.306	190	0.453
60	0.176	130	0.327	200	0.474

FACTOR OF EVAPORATION.

As the Factor of Evaporation for the pressures and temperatures of feed-water usually occurring in locomotive practice varies between 1.15 and 1.25, we may consider 1.2 as an average value.

INTERNAL FRICTION.

Wellington places the Internal Friction of the locomotive (not including the journal and rolling friction) at from 5 to 8 per cent of the indicated power; Forsyth (C. B. & Q.) at 10 per cent; and *Engineering News* (Vol. 27, page 585) at 5 per cent. It may, therefore, be assumed at from 5 to 10 per cent of the indicated power, or in round numbers the theoretical tractive force (indicated tractive force) may be taken as 10 per cent greater than the actual tractive force, which actual tractive force is utilized not only in drawing the train, but in overcoming the journal and rolling friction of the engine and tender as well, these to be taken at the same rate as the train itself.

TRACTIVE FORCE.

As is well known, the theoretical tractive force is represented by the equation :

$$\text{Theoretical tractive force} = \frac{p\,d^2\,s}{D} \text{ in pounds.} \qquad (1)$$

where p = mean effective pressure in pounds per square inch,
d = diameter of cylinder in inches,
s = stroke in inches,
D = diameter of driving wheel in inches.

From what we have seen above, we can therefore write

$$\frac{p\,d^2\,s}{D} = 1.1\,(y_1 + y_2 + y_3 + y_4)\,T \qquad (2)$$

where T = weight of train in net tons, including the engine and tender,
and y to be taken from Diagram No. 1.

The mean effective pressure depends principally upon two factors, the boiler pressure and the cut-off, modified by the initial pressure and the speed, which reduces the cut-off pressure below the initial. While the mean effective pressure fixes the tractive force, yet the actual cut-off pressure bears an important effect upon the tendency to slip the wheels at different parts of the revolution.

If we consider the friction between the wheels and rail to be 22 per cent of the adhesive weight, and a loss of 10 per cent due to the internal friction of the engine, we can conclude that the theoretical rotative force at the circumference of the wheel must never exceed 25 per cent of the weight on the drivers. Table F gives the ratio of maximum rotative force to average rotative force at various cut-offs and cut-off pressures, for a connecting rod whose length is 9½ times the crank radius, or about five times the stroke. Other lengths will show but little variation from table.

TABLE F.

RATIO OF MAXIMUM ROTATIVE FORCE TO AVERAGE ROTATIVE FORCE AT VARIOUS CUT-OFFS.

Cut-Off Pressure.	CUT-OFF AT							
	⅛	¼	⅜	½	⅝	¾	⅞	1
100	1.52	1.31	1.17	1.09	1.10	1.17	1.19	1.20
200	1.47	1.30	1.11	1.09	1.12	1.16	1.19	1.19
Approximate average.	1.50	1.30	1.15	1.10	1.10	1.15	1.18	1.20

The point of maximum rotative force varies 15° each side of the 45° point.

To prevent slipping we may therefore conclude that the average tractive force should not exceed 22 per cent of the adhesive weight, as this would prevent the maximum rotative force exceeding the 25 per cent found above, in all but the ⅛ and ¼ cut-off, and as the speeds are generally high at these points, the inertia of the wheels, etc., would probably prevent slipping at the maximum points. Diagram No. 2 gives the ratio of mean effective pressure to initial pressure that may be expected, with various cut-offs and speeds, but the mean effective pressure must never exceed $\frac{0.22\ W\ D,}{d^2\ s}$ where $W =$ the weight on drivers; so also we should always have

$$1.1\ (y_1 + y_2 + y_3 + y_4)\ T = \text{or} < 0.22\ W \qquad (3)$$

In 1887, a committee of this Association advised that the coefficient of friction between the wheel and rail might be taken at 25 per cent for passenger and 23 per cent for freight locomotives. This committee also recommended using the diameter of wheel, when the tire was half worn, instead of the diameter when new, in figuring the tractive force. This would give us values of about 24 per cent and 22 per cent for passenger and freight respectively, when the full diameter was used, so your committee accepted 22 per cent as the proper coefficient in both cases.

EVAPORATION.

Diagram No. 3 and Tables D and E enable the weight of the steam used per stroke to be determined, and Table B the weight of steam per hour. This, of course, is the "water accounted for by indicator" and should have about 25 per cent added for condensation and other losses. It should also be multiplied by the factor of evaporation, 1.2, to obtain the amount of water from and at 212°.

EXAMPLES.

We have now before us sufficient data to calculate the performance of a given locomotive, or to proportion the grate area and heating service for a locomotive to do a given amount of work, when the kind of fuel to be used is also known. Let us first examine a couple of cases where the results are known. Take a 10-wheel engine, 19 by 24 inch cylinder, 60-inch drivers, boiler pressure 150 pounds, 28 square feet grate area, and with 100,000 pounds on drivers. This engine is capable of pulling a passenger train of 300 tons gross weight, up a 70-foot grade at a speed of 30 miles per hour, the fuel being Pocahontas coal. From Diagram No. 1 it is found that the value of y_1 at 30 miles per hour is 9, and the value of y_2 on a 70-foot grade is 27, making a total resistance of 36 pounds per ton. Therefore we have (allowing the 10 per cent for internal friction above referred to) $36 \times 300 \times 1.1 = 11,880$ pounds, say 12,000 pounds total resistance. The mean effective pressure necessary to do this work would therefore be $\frac{12,000 \times D}{d^2 s} = p$ (see formula 2), or $\frac{12,000 \times 60}{361 \times 24} = 83$ pounds M. E. P., and as the initial pressure may be 140 pounds, we find from Table C that the M. E. P. is 60 per cent of the initial pressure. From Table B it can be seen that a 60-inch wheel makes 168 revolutions per minute at 30 miles per hour, while from Diagram No. 2 it is found that with Allen valves (which this engine uses) a cut-off of about 50 per cent is necessary. From Diagram No. 3, it appears, that with 50 per cent cut-off and 168 revolutions per minute, the cut-off pressure will be about 78 per cent of the initial pressure. From Table C this is found to be about 110 pounds per square inch, and Table D gives the volume of a 19-inch cylinder 12 inches long as 1.97 cubic feet, or say 2 cubic feet of steam per stroke. Table E shows the weight of steam per cubic foot at 110 pounds pressure to be 0.284 pounds, and allowing the factor of evaporation 1.2, and the 25 per cent for condensation, etc., we have:

$$\left.\begin{array}{l}\text{Pounds of water per hour}\\ \text{from and at } 212^\circ\end{array}\right\} = 2 \times 4 \times 168 \times 60 \times 0.284 \times 1.2 \times 1.25 = 34,352.$$

Now, allowing 6½ pounds water per pound of coal (on account of the high rate of combustion), and also dividing by the 28 square feet of grate area, we have

$$\frac{34,352}{6.5 \times 28} = 189 \text{ pounds of coal per square foot grate area per hour,}$$

which, it will be evident, is about the maximum capacity of the engine. Let us examine the Madison Hill tank locomotive of the P. C. C. & St. L., the information regarding which was kindly furnished by Mr. Bush, Supt. M. P. This engine has 22 by 28 inch cylinders, 50-inch drivers, 150 pounds boiler pressure, 27 square feet grate area, 1,672 square feet heating surface, plain valves with 18-inch ports, and hauls freight trains of a gross weight of 207 tons up a 311-foot grade at 10 miles per hour. The cut-off used is about ½ stroke, and 500 to 600 pounds Pittsburg coal are used on the round trip, with some switching.

Proceeding as in the last example, $y_1 = 5$ and $y_2 = 118$, total $= 123$, and $207 \times 123 \times 1.1 = 28,007$ pounds resistance.

$\frac{28,007 \times 50}{484 \times 28} = 103$ pounds M. E. P., and as speed is slow the initial pressure will be nearly 150 pounds and M. E. P. will be 69 per cent of boiler pressure. At 10 miles per hour, there will be made 67 revolutions per minute, and we find by Diagram No. 2 that the cut-off should be about 56 per cent. This agrees well with Mr. Bush's figures stated above. Proceeding as before, the cut-off pressure would be 79 per cent of the boiler pressure or 117 pounds per square inch, and steam would weigh 0.3 pounds per cubic foot, therefore

$$3.4 \times 4 \times 67 \times 60 \times 0.3 \times 1.2 \times 1.25 = 24{,}603, \text{ and}$$

$$\frac{24{,}603}{7 \times 1{,}672} = 2 \text{ pounds coal per square foot heating surface, and}$$

$$\frac{24{,}603}{7 \times 27} = 130 \text{ pounds coal per square foot grate area per hour, or a}$$

total of 3,500 pounds coal per hour. As the hill is about 1½ miles long, it would take about 10 minutes, or $\frac{3{,}500}{6} = 585$ pounds of coal for the ascent. This also agrees fairly well with the original statement.

These two examples have been given in order to illustrate the use of the diagrams and tables, and to show that the former are reasonably accurate.

We will now proceed to illustrate how the amount of heating surface and grate area can be determined from the foregoing data, when the cylinders, wheels, etc., of the locomotive have been decided upon, these, of course, having been determined by means of formulæ 1, 2 and 3 and the data following them. To do a certain amount of work we can use a smaller cylinder and cut-off later, or a larger cylinder and cut-off earlier; the diagrams and formulæ giving the results in either case. In order to work out some typical cases, it will be necessary to start with certain assumptions. Of course it should be understood at the outset that the proportions so obtained only hold good when the assumptions are adhered to, but your committee believes that the assumed ratios agree fairly well with current practice. Later on it will be shown how the results agree with locomotives in successful operation.

Let us consider first that at the average work (that is, the work performed during most of the run) steam should be used at the most economical rate. This seems to be pretty generally conceded to be at ¼ cut-off for simple and ½ cut-off for compound locomotives. It is also considered that while the maximum speed of a locomotive in miles per hour will be closely represented by the diameter of its wheel in inches, that the average speed at which it does most of its work will be about half that speed, or at 168 revolutions per minute. (Our figures now refer to passenger locomotives only.)

Cut-off at ¼ stroke and 168 revolutions give by Diagram No. 3 a cut-off pressure of about 70 per cent of initial pressure, which if we assume to be 160 pounds will give us 110 pounds at cut-off, weighing 0.284 pounds per cubic foot.

Letting V_t = the volume in cubic feet of both cylinders (that is, 2 × area × stroke), we now have: Water per hour from and at 212° in pounds =

$$\frac{V_t}{4} \times 2 \times 168 \times 0.284 \times 1.2 \times 1.25 \times 60 = 2{,}147\ V_t, \text{ or say, } 2{,}150\ V_t \tag{4}$$

If for freight engines we assume ⅓ cut-off and 120 revolutions per minute, we have nearly the same result, namely, 2,150 V_t.

So far we have proceeded without any reference to the fuel used, but now we must make more assumptions, and decide that an economical rate of evaporation should be maintained under the above conditions. From Diagrams 4 and 5 it appears that large anthracite will evaporate 8 pounds of water per pound of coal, when the rate of combustion is 1½ pounds per square foot heating surface per hour and about 60 pounds per square foot grate area. This will give, for large Pennsylvania anthracite coal,

$$\text{Heating surface in square feet} = \frac{2{,}150}{8 \times 1.5} V_t = 180 V_t \qquad (5)$$

$$\text{Grate area in square feet} = \frac{2{,}150}{8 \times 60} V_t = 4.5 V_t \qquad (6)$$

For fine Pennsylvania anthracite, 6½ pounds water at 1½ pounds per square foot heating surface and 35 pounds per square foot grate area,

$$\text{Heating surface in square feet} = \frac{2{,}150}{6.5 \times 1.5} V_t = 220 V_t \qquad (7)$$

$$\text{Grate area in square feet} = \frac{2{,}150}{6.5 \times 35} V_t = 9.6 V_t \qquad (8)$$

For Virginia semi-bituminous, 9 pounds water at 1 pound per square foot heating surface and 65 pounds per square foot grate area,

$$\text{Heating surface in square feet} = \frac{2{,}150}{9 \times 1} V_t = 240 V_t \qquad (9)$$

$$\text{Grate area in square feet} = \frac{2{,}150}{9 \times 65} V_t = 3.7 V_t \qquad (10)$$

For Illinois bituminous coal, 7 pounds water at 1½ pounds per square foot heating surface and 90 pounds per square foot of grate surface,

$$\text{Heating surface in square feet} = \frac{2{,}150}{7 \times 1.5} V_t = 205 V_t \qquad (11)$$

$$\text{Grate area in square feet} = \frac{2{,}150}{7 \times 90} V_t = 3.4 V_t \qquad (12)$$

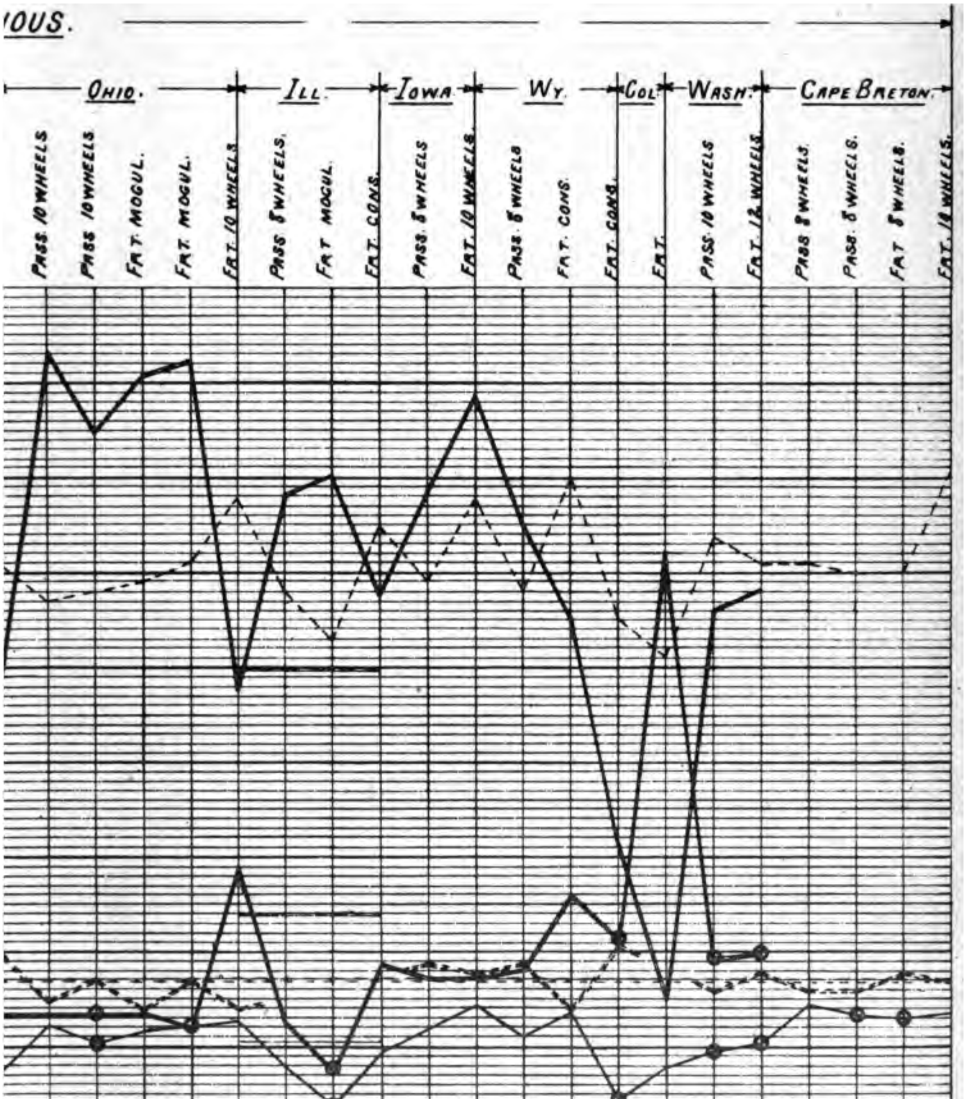
In ascending heavy grades the fires will be forced to two or three times the rate specified above, in which case the cut-off may be 0.5 or 0.6, or even 0.75 of the stroke, thus greatly increasing the work of the engine, as we saw in the first two examples. Of course there is a limit to the rate of combustion, which seems to be about 200 pounds per square foot of grate area per hour for bituminous coal. Your committee could not ascertain the limit for anthracite coal, but it is evidently much lower.

It must be borne in mind, that we can vary the results greatly by altering the various factors in the assumptions, as for instance the evaporative power of the coal; a slower rate of combustion giving a greater evaporative power. The values chosen are about the average of our recorded curves for a moderate and economical rate of combustion.

Having now passed over the analytical deductions, or what might be called, the theoretical aspect of the question, it will be in order to review the values of heating surface, grate area, etc., which are in use at the present time and giving satisfactory service. In order to determine, if possible, the line between satisfactory and indifferent steaming capabilities, the circular which your committee sent out was so framed that it would encourage replies relating to poor steamers, the committee guaranteeing to suppress the name of the road giving the information.

OTIVES.

DIAGRAM No. 6



rs. Diagram lines which are wholly horizontal indicate hypothetical cases.

The general data, while used for grade reductions and engine ratings, have not been fully tabulated; accordingly, I am not able at this time to give you the results, which I regret.

"I may say in advance, however, that the experiment showed our engines to be very deficient in steaming power in all cases where they were called upon to overcome high resistance, at speeds over twelve or fifteen miles per hour, and we have ascertained on many of the divisions of high resistance that the train length is determined by the ability of the engine to develop horse-power, and is almost independent of the weight on the drivers.

"All divisions of continuous rise, as in the valley sections, show abnormal horse-power requirements for speed over 20 miles per hour, and in ordering engines for such sections in the future we shall specify much higher evaporative requirements than heretofore.

"I cannot comply with your request to fill in the attached circular, regarding the engines which do not steam well, as my statement practically applies to all engines on our road, when working under conditions to which they are not adapted. . . . We conclude, from our recent experiments, that an engine must be adapted as nearly as practicable to the division to which it is assigned. For example: We have two divisions upon which the ruling maximum rate of grade is the same, taxing adhesion to the same extent in both cases. In the one case, however, the grades are undulating, while in the other we have an average rise per mile of about eleven feet. In the first case, while adhesion is taxed to the limit, on the intermittent sections of maximum grade, the tax on the boiler is obviously limited to the horse-power required to move the train at schedule speed against the *average rolling resistance only*, and the grade resistance may be neglected in computing the horse-power requirements, as the acquired momentum of the train on light grades or in sags constitutes an addition to the power of the engine in assisting the train over the rises, and the draft on the boiler on down grades is small.

"In the second case, the engine has to overcome the same rolling resistance, plus the work done against gravity in rising *continuously* eleven feet per mile, and if the speed is the same, the work done in horse-power hours over the same distance is very much higher — in this particular instance about double.

"With steam-making capacity unchanged, it is quite certain the speed must be reduced one-half to haul the same train, or the resistance decreased one-half to haul the train at the same speed. This latter alternative, of course, means a shorter train. Maintaining the train length constant may result in a schedule undesirably slow, and in such cases it is the universal practice to shorten the train length sufficiently to make the arbitrarily established schedule time. In our own case, this has led to a reduction in the train length of ten cars, as the same engine, at the same rate of speed, can furnish steam to haul thirty-five cars over the undulating division and but twenty-five cars over the division of continuous rise. In the first case the adhesion is fully taxed at infrequent intervals, on the maximum grades, whereas, in the second case, the adhesion is not fully utilized at any time.

"To sum up, the weight on drivers should be proportioned to the *maximum* rates of grade, while the steam-making capacity should be proportioned to the *average* resistance and schedule speed, as an engine of given weight on drivers, designed to develop a given horse-power, would utilize its full adhesion, under favorable conditions, while under other conditions it would utterly fail to develop sufficient horse-power to utilize even 50 per cent of the adhesion due to weight on drivers. We, therefore, expect to provide engines of greater horse-power for the same weight on drivers, for divisions of high resistance, than are provided for divisions of low resistance."

G. R. HENDERSON,
A. S. VOGT,
R. WELLS,
S. M. VAUCLAIN,
C. J. MELLIN,
Committee.

ROANOKE, VA., April 7, 1897.

On motion of Mr. Herr, the report was received and opened for discussion.

MR. HERR: Mr. President, the report of this committee gives evidence of so large an amount of labor and such a vast compilation of interesting data that it is exceedingly difficult to take hold and discuss it without a great deal more preparation than I have been able to give to the report. It certainly covers a field which has been almost entirely neglected heretofore, and gives us, so far as I know, the first comprehensive method and detailed information for the complete calculations of the principal dimensions of locomotive engines for different classes of service and under different fuel conditions. I certainly think that the thanks of the Association are due to the committee for the admirable report it has made.

It is interesting to note the very great difference in the ratios of grate area to cylinder volume for the different classes of coal, the anthracite being so much larger than the bituminous, which, of course, again appears in the small relative ratio of heating surface to grate area. The charts given by the committee are exceedingly interesting and extremely valuable. I am not exactly clear as to just what the scope of the charts is, and would like to ask the committee to explain some of these charts; for instance, Diagrams Nos. 2 and 3. They very properly have given zones covering considerable latitude for each particular kind of valve motion. In using these, it is of course very important to know just about where in that zone a particular kind of valve motion should be placed, and I think perhaps the chairman of the committee can give us very briefly some information that may be of value. Perhaps a large amount of it is to be found in the report, as would be evidenced by a more careful reading than I have been able to give it.

I would like to say a word in regard to the last paragraph of the letter quoted by the committee. It is stated in this last paragraph

Table D.

22"	23"	24"	25"	26"	27"	28"	29"	30"
0·99	1·03	1·08	1·12	1·17	1·21	1·26	1·30	1·35
1·21	1·26	1·32	1·37	1·43	1·48	1·54	1·59	1·65
1·43	1·49	1·56	1·62	1·69	1·75	1·82	1·88	1·95
1·69	1·77	1·85	1·92	2·00	2·08	2·16	2·23	2·31
1·96	2·05	2·13	2·22	2·31	2·40	2·49	2·58	2·67
2·24	2·35	2·45	2·55	2·65	2·75	2·86	2·96	3·06
2·55	2·67	2·78	2·90	3·02	3·13	3·25	3·36	3·48
2·90	3·04	3·17	3·30	3·43	3·56	3 70	3·83	3·96
3·23	3·38	3·53	3·67	3·82	3 97	4·12	4·26	4·41
3·61	3·77	3·94	4·10	4·26	4·43	4·59	4·76	4·92
4·00	4·19	4·37	4·55	4·73	4·91	5·10	5·28	5·46
4·40	4·60	4·80	5·00	5·20	5·40	5·60	5·80	6·00
4·84	5·06	5·28	5·50	5·72	5·94	6·16	6·38	6·60
5·28	5·52	5·76	6·00	6·24	6·48	6 64	6·96	7·20
5·74	6·00	6 26	6·52	6·79	7·05	7·31	7·57	7·83
6·25	6·53	6·82	7·10	7·38	7·67	7·95	8·24	8·52
6·75	7·06	7·37	7·68	7·98	8·29	8·60	8·90	9·21
7·28	7·61	7·94	8·27	8 61	8·94	9·27	9·60	9·93
7·83	8·19	8·54	8·90	9·26	9·61	9·97	10·32	10·68
8·40	8·79	9·17	9·55	9·93	10 31	10·70	11·08	11·46
9 00	9·41	9·82	10·22	10·63	11·04	11·45	11·86	12·27

illustrate very closely what may be considered American locomotive practice. Of course, some distinction must be used — for instance, on Diagram No. 2, for ninety per cent cut-off, the curve is extended to 250 revolutions; there is no boiler in this country that could furnish steam at ninety per cent cut-off for that.

PROFESSOR GOSS: I would like to express my appreciation of the work of this committee. As a piece of analysis, it seems to me to be exceptionally fine. Of course, the accuracy of the calculations depends upon the accuracy of the data upon which the analysis is based. I believe the committee has used as reliable information as it can find. I look at it chiefly, however, as of very great interest because of the ingenious analysis. It is a very pretty piece of work.

THE PRESIDENT: If there is no further discussion, we will proceed to the consideration of the report of Committee on Boiler Jackets. Mr. T. B. Purves, Jr., chairman.

Mr. Purves presented the following report:

REPORT OF THE COMMITTEE ON BOILER JACKETS.

To the President and Members of the
American Railway Master Mechanics' Association:

Your committee appointed to report upon the question, "Which is the most economical, a boiler jacket of planished iron, or a boiler jacket of common sheet iron, or sheet steel painted? The general appearance, first cost and cost of maintenance to be considered," presents herewith the questions contained in their circular of inquiry, together with a synopsis of the replies received to the same.

The catechetical style was adopted for the report in order to render its contents convenient for reference.

1. How often do you find it necessary to paint steel or sheet iron jackets?

The replies received from American railways vary between twice a year and once in two and one-half years, but the majority of the replies recommend that jackets be painted every six months.

A great deal depends upon the kind of paint used and the method of applying it; the character of the service to which the jacket is subjected, and the condition of the roundhouses.

The Manchester, Sheffield & Lincolnshire Railway paints its jackets about every three years, while the Ferro-Carril Gran Oeste Argentino Railway paints sheet iron jackets every year.

The Norfolk & Western Railway is of the opinion that a planished iron jacket painted over is not so durable as a sheet iron or steel jacket painted; and the Northern Pacific Railway believes that sheet iron jackets should be painted twice as often as those of sheet steel.

The Toledo, Ann Arbor & North Michigan Railroad paints planished iron jackets every fifteen or eighteen months, and the Delaware, Lackawanna & Western Railroad paints its jackets whenever the gloss begins to wear off, or they show signs of rust.

Some roads paint sheet iron and steel jackets whenever a new jacket is applied, or an old one replaced; or whenever locomotives are painted; or are in the shop for general repairs, say once every 50,000 to 100,000 miles.

2. What color and quality of paint do you use, and what is the cost per square foot, labor and material included?

Condensed replies to this question are as follows:

Use black enamel jacket varnish (cost not given).

Use two coats of black asphaltum, coating 7.7 cents per square foot complete.

Use two coats of Rogers' black locomotive finish, costing about .6 cent per square foot to paint.

Use Rogers' black locomotive finish, costing 1/3 cent per square foot, for labor and material.

Use Rogers' black locomotive finish outside, and brown mineral paint inside. Cost of labor and material, .6 cent per square foot.

Use Acme locomotive Russia jacket enamel, which resembles Russia iron, costing 2 cents per square foot.

Use one coat of Murphy's " A " surfacer, costing $2.75 per gallon; two coats of Black Nile engine finish, costing $2.50 per gallon; and one coat of varnish.

Use one coat of Bellamy filler, sandpapered down. One coat of flat black, and one coat of black enamel varnish, costing as follows: Labor, $4.33; material, $2.62; total, $6 95 per engine. This jacket is of steel, and after seven months of service is still in good condition.

For new jackets, use one coat of lead primer and one coat of black engine finish, costing .75 cent per square foot, for labor and material. For repainting old jackets, use one coat of engine finish, costing .5 cent per square foot complete.

Use black engine finish, costing $2.50 per gallon, and .69 cent per square foot.

Use black colors and varnish, costing 2 cents per square foot, for labor and material.

Use black engine finish and finishing varnish, costing 1 cent per square foot, for labor and material.

Use two priming coats of mineral paint and one coat of varnish black, at a total cost of 1 cent per square foot.

Use one coat of Rogers' black locomotive finish outside, and one coat of Prince's mineral paint inside, costing about 1.5 cents per square foot, for labor and material.

Inside, use one coat of freight car color. Outside, use one coat of surfacer "A," two coats of Rogers' locomotive finish, one coat of engine varnish (passenger engines), color Brunswick green. Cost of labor and material per square foot as follows: Class "R," .0154; Class "S," .018; Class "O," 160 L. B. S., .027; Class "O," 140 L. B. S., .0277; Class "I," .0203; Class "M," .0204; Class "P," .0226.

(The above refers to the Pennsylvania Lines West of Pittsburgh.)

The Manchester, Sheffield & Lincolnshire Railway, and the Ferro-Carril Gran Oeste Argentino Railway, reply respectively as follows:

Color, Gorton green; quality, Docker's Birmingham, costing 2.96d. per square foot.

Jackets are painted black, rubbed down, flatted and lined. Two coats of lead color paint, one coat of stopping (spread on with a knife), one coat of filling, two coats of black, and three coats of varnish are applied. The cost of material is $9.66 gold; cost of labor, $9.60 gold; cost per square foot, $0.06 gold.

The Chicago & North-Western Railway states that with planished iron jackets a coating of benzoin paste, or Black Eagle polish, is used about once a week, when the planished surfaces wear off. This polish is sold by the Nickel Plate Stove Polish Company, of Chicago, in 1-pound boxes, at 10 cents a box, and restores the jacket to nearly its original color.

3. Do you think it advisable to paint inside of jacket before applying? If so, please give your reasons for so doing, and state the kind of paint used.

It is the almost universal opinion that it is necessary to paint the inside of all jackets prior to application, in order to prolong their life by preserving them from internal rusting and corrosion. This painting is particularly desirable when fresh wood lagging is used, as the aciduous moisture arising from the sweating or steaming of the latter will, especially when the engine is cold, adhere to the jacket surface, and cause quite rapid corrosion of the latter.

The Northern Pacific Railway reports that this corrosive action is more noticeable with sheet iron than with either steel or planished iron jackets; and the Norfolk & Western Railway states that the internal oxidation of unpainted jackets is especially rapid when asbestos cement boiler coverings are employed.

Condensed replies relative to the kind of paint used are as follows:

Use P. & B. asphalt paint, which preserves iron, and withstands an enormous amount of heat.

Use oxide of iron paint.

Three use Princess metallic paint.

Two use Price's metallic paint.

Use brown metallic paint.

Use metallic or roof paint.

Use red metallic paint.

Use metallic paint.

Use good mineral paint with boiled oil, costing 55 cents for jacket of ordinary size.

Use mineral red, best quality oil color, at a cost of 1.25 cents per square foot.

Use mineral paint and linseed oil mixed, costing .58 cent per square foot for labor and material.

Two use brown mineral paint.

Use mineral paint.

Use slate-color oil paint.

Three use freight car paint.

4. From your experience, do you find that jackets wear out from external abrasion or from inside rusting, or both?

Twelve replies to this question state that jackets wear out from both external abrasion and inside oxidation, three of these replies specifying the latter as the principal cause of deterioration, and the Southern Pacific Railway stating that the loss of jackets from inside rusting is about sixty per cent in excess of that occasioned by external abrasion.

Ten replies state that jackets wear out from inside oxidation.

The Chicago, Rock Island & Pacific Railway states that leaking boiler seams are the jacket's worst enemy, although the sweating of the boiler may at times cause moisture to condense on the inside of the jacket and produce oxidation of the latter, if unprotected by paint.

The Baldwin Locomotive Works replies that according to its experience the wearing out of jackets is usually due to the general carelessness of employes in charge of the management and repair of locomotives, no care being taken to prevent jackets from rusting, or from being walked over and hammered out of shape. This is especially the case where wood lagging is used, and has become charred or burned off.

The Chicago & North-Western Railway states that if the jackets are painted inside when new, and again whenever they are removed, there is practically no internal corrosion; consequently the wear is from external abrasion.

The Union Pacific Railway states that jackets wear out from external abrasion, and from corrosion due to acid drippings from the roundhouse roof.

5. From your experience, what do you consider the average life of planished iron jackets when used over wood lagging?

The average of the mean life given in the different replies to this question is 10.57 years; the minimum and maximum life mentioned being 2 years and 12 years, respectively.

The Delaware, Lackawanna & Western Railroad reports that it has Russia iron jackets which have been more than twenty years in service, the jackets being now painted.

The life of any jacket is, of course, largely dependent upon the care taken of it; the character of the service to which it is subjected; the frequency of its removal from the boiler; the tightness of the seams of the latter; and the condition of the roundhouses.

6. When a boiler covering other than wood is used under a planished iron jacket, have you found that the life of the latter is influenced thereby? If so, to what do you attribute the influence?

Five replies state that no material difference is observable in the life of planished iron jackets when used over either wood or other boiler coverings, provided that the latter contain no lime in their composition, and the boiler and jacket seams are properly cared for.

Seven replies state that jackets last longer over wood than over mineral coverings, because the lime usually contained in the latter will pit and corrode the jacket, should any moisture reach the lagging from leaks in the boiler or jacket seams.

The Baldwin Locomotive Works states that asbestos cement should not be used unless all the corrosive substance it contains be neutralized, and the surface of the lagging after application to the boiler covered with P. & B. asphalt paint. Unless these precautions are taken, the asbestos will act corrosively on both the boiler and the jacket.

Four replies state that jackets are much more durable over magnesia than over wood lagging, the moisture distilled from the latter (when not thoroughly dried) being absent, and there being no inside rusting of the jacket unless occasioned by a leak in the boiler.

The Grand Rapids & Indiana Railroad reports that when coverings other than illustrate very closely what may be considered American locomotive practice. Of course, some distinction must be used — for instance, on Diagram No. 2, for ninety per cent cut-off, the curve is extended to 250 revolutions; there is no boiler in this country that could furnish steam at ninety per cent cut-off for that.

PROFESSOR GOSS: I would like to express my appreciation of the work of this committee. As a piece of analysis, it seems to me to be exceptionally fine. Of course, the accuracy of the calculations depends upon the accuracy of the data upon which the analysis is based. I believe the committee has used as reliable information as it can find. I look at it chiefly, however, as of very great interest because of the ingenious analysis. It is a very pretty piece of work.

THE PRESIDENT: If there is no further discussion, we will proceed to the consideration of the report of Committee on Boiler Jackets. Mr. T. B. Purves, Jr., chairman.

Mr. Purves presented the following report:

REPORT OF THE COMMITTEE ON BOILER JACKETS.

To the President and Members of the
American Railway Master Mechanics' Association:

Your committee appointed to report upon the question, "Which is the most economical, a boiler jacket of planished iron, or a boiler jacket of common sheet iron, or sheet steel painted? The general appearance, first cost and cost of maintenance to be considered," presents herewith the questions contained in their circular of inquiry, together with a synopsis of the replies received to the same.

The catechetical style was adopted for the report in order to render its contents convenient for reference.

1. How often do you find it necessary to paint steel or sheet iron jackets?

The replies received from American railways vary between twice a year and once in two and one-half years, but the majority of the replies recommend that jackets be painted every six months.

A great deal depends upon the kind of paint used and the method of applying it; the character of the service to which the jacket is subjected, and the condition of the roundhouses.

The Manchester, Sheffield & Lincolnshire Railway paints its jackets about every three years, while the Ferro-Carril Gran Oeste Argentino Railway paints sheet iron jackets every year.

The Norfolk & Western Railway is of the opinion that a planished iron jacket painted over is not so durable as a sheet iron or steel jacket painted; and the Northern Pacific Railway believes that sheet iron jackets should be painted twice as often as those of sheet steel.

The Toledo, Ann Arbor & North Michigan Railroad paints planished iron jackets every fifteen or eighteen months, and the Delaware, Lackawanna & Western Rail-

Class of Engine.	Planished Iron.	Sheet Iron.	Sheet Steel.
"R"	.1658	.062	.0675
"S"	.1642	.062	.0675
"O" 140 lbs.	.1538	0577	.063
"O" 160 lbs.	.1515	.0572	.0626
"I"	.1799	.0636	.0736
"M"	.1534	.0583	.0634
"P"	.1399	.0535	.0581

The Manchester, Sheffield & Lincolnshire Railway gives the cost of sheet-steel jackets at 2.6d. per square foot.

The Chicago, Rock Island & Pacific Railway states that the so-called "pickled" cold rolled steel was tried as a substitute for planished iron, but was found to be unsatisfactory; while the Chicago, Burlington & Quincy Railway reports that the use of both planished and sheet-iron jackets has been abandoned, and "pickled" steel jackets, costing 5 cents per square foot, substituted in their stead.

9. What thickness of material is used?

The replies to this question show as follows in Master Mechanics' Standard Gauge:

Two use .020, five use .022, six use .025, nine use .028, one uses .032, one uses .036 and one uses .070.

In these replies the thicknesses for planished iron reported as follows:

One .020, two .022, two .025 and one .028.

For sheet iron:

One .022, one .036.

For sheet steel:

Two .022, one .028, one .050 and one .070. One party reports using .036 inch planished iron for bands.

The Manchester, Sheffield & Lincolnshire Railway, and the Ferro-Carril Gran Oeste Argentino Railway, use, respectively, Nos. 14 and 16 British Imperial Standard Wire Gauge, equivalent to .080 and .065 respectively.

10. Do you find the effect of the acid-laden moisture which drops from the roof of roundhouses more injurious to plain iron and steel jackets than to planished jackets, and to what extent does this cause of deterioration affect the renewing and repainting of jackets.

It is the prevailing opinion that properly painted sheet iron and steel jackets are *less* seriously affected by the acid-laden moisture than are planished jackets, on account of the protection afforded to the former by the paint.

These acid drippings are very injurious to planished iron jackets, and unless they are promptly washed off will quickly destroy the planished surface, and render renewals necessary.

The acid also attacks the paint on sheet iron and steel jackets, but in this case the bare spots can be repainted and the injury remedied at a trifling expense.

Benzoin paste is recommended as an efficient protection for planished iron jackets.

The effect of the acid-laden moisture upon the jackets is largely dependent upon the care taken of the latter. If kept properly cleaned, a planished iron jacket will last a long time, but if the moisture is not removed, a well painted iron or steel jacket will probably give the better service.

The Ferro-Carril Gran Oeste Argentino Railway states that by the use of smoke troughs and chimneys of wood, the acid laden moisture is so greatly reduced that but little, if any, is precipitated upon the locomotives.

11. Do you find that jackets placed over magnesia or asbestos laggings rust away more rapidly than jackets placed over wood lagging, and are plain iron or steel jackets more susceptible to this effect than are planished iron jackets?

The replies to the first part of this question are so conflicting that generalizations are impossible, but the three replies received to the last part agree that plain iron or steel jackets are *not* more susceptible to internal rusting than are planished jackets, if all are kept properly painted.

Five replies state that jackets placed over magnesia or asbestos lagging rust away more rapidly than jackets placed over wood lagging. To remedy, or reduce this evil, it is suggested that the lagging be covered with an oiled paper prior to the application of the jacket, or that the inside of the latter be thoroughly painted.

With some boiler coverings the jackets are eaten away from the inside in two years, but this effect is usually produced by laggings which contain lime in their composition.

Three replies state that asbestos lagging is productive of more rapid rusting of the jacket than either magnesia or wood coverings; while three replies state that jackets placed over properly applied asbestos lagging will last as long, or longer, than jackets placed over wood.

Six replies state that jackets placed over magnesia lagging are more durable than jackets placed over wood lagging, while one reply states that with the former covering a jacket will last at least as long as with the latter.

It is claimed by several master mechanics that when a leak occurs in the boiler, the wood lagging permits the steam to spread all under the jacket, while the magnesia and asbestos coverings tend both to confine and absorb the issuing steam and water. The jacket is also far better supported by the latter coverings than by the former; it is therefore less liable to be dented or otherwise mechanically injured, and the possibility of the lagging taking fire is eliminated.

CONCLUSIONS.

From a careful consideration of the foregoing, and especially of the replies received to questions 1, 2, 7, 8 and 10, your committee concludes that it is more economical to use boiler jackets of common sheet iron, or sheet steel painted, than it is to use jackets of planished iron. Respectfully submitted,

T. B. PURVES, JR., Chairman,
C. G. TURNER,
A. E. MITCHELL,
J. E. SAGUE,
EDWARD L. COSTER,
Committee.

On motion of Mr. Sinclair, the report was received and the committee discharged.

THE PRESIDENT: The report is open for discussion.

MR. McINTOSH: I note on page 3 it states that the Chicago & North-Western Railway uses benzoin paste about once a week on jackets. This would imply it was a general practice of the North-Western Road. This is not so, but it was only used experimentally. In the few cases where we have applied it in this manner to an old jacket, we have found that it brightened it up and it lasts very well. An application about once a week, rubbing it up about the same as we would a stovepipe, brightens it very nicely.

There being no further discussion, the convention adjourned until the following day.

THIRD DAY'S PROCEEDINGS.

The convention was called to order on Thursday, June 17, at 9:20 A.M.

THE PRESIDENT: Gentlemen, we will resume our work now by taking up report on Piecework in Locomotive Repair Shops. Mr. Leeds is chairman of the committee.

MR. LEEDS: Mr. President and Gentlemen,—As this is all printed and before you, I do not think there is any necessity of even reading it in abstract, as the whole of it is contained in the recommendation from the fact that the practice of piecework is, very generally speaking, most heartily indorsed by those who have it most extensively in use. At the same time, I would call attention to the fact that under Question No. 4, it has been almost impossible to get any data on which we could really base an opinion as to what was the best method in regard to this question—as to whether it applied equally well to new and repair work. In almost every case the statement was made that it would be practically impossible to give prices or data that would apply unless a competent person could visit the shops and see the methods under which they applied it. There are always conditions arising, especially with regard to new work, that have to be adjusted through the judgment of the foreman, or in some other way.

The report submitted by the committee is as follows:

REPORT OF THE COMMITTEE ON PIECEWORK IN LOCOMOTIVE SHOPS.

To the President and Members of the
American Railway Master Mechanics' Association :

Your committee, appointed to report on the advisability of " Piecework in Locomotive Shops," issued a circular of inquiry, to which there have been forty-one replies.

The first paragraph reads as follows :

1. Have you introduced the piecework system in all of the departments of your shops on new and repair work ? If not, to what extent have you introduced it ?

To this twenty-four reported that they had not introduced piecework in their shops; nine of them answered yes; seven answered that they had introduced it to some extent, but not so as to say that it was their practice.

2. If you have not yet inaugurated it, do you think it advisable to do so, or have you objections to the system ? If so, please state your objections fully.

To the second inquiry there were twenty-six who answered that they considered it fully advisable; six reported that they had tried it and had not received satisfactory results; two that they thought the gain would be more than counterbalanced by the extra supervision and clerical force needed to keep up with the details; seven answered that they had not introduced it and could give no opinion, or at least, did not.

3. If you have the system in operation, to what extent has it increased the output of your shops, and to what extent has it decreased the cost of labor per unit ?

The reduction reported in the case of output ranges from ten to thirty-five per cent. In some of those reporting twenty-five and thirty per cent, they accredited about one-half of the reduction due to piecework, and the other one-half to improved machinery and enforced economy.

4. Do you think it is equally applicable to new and to repair work ?

To this there were seventeen affirmative replies and fourteen negative; at the same time, in the seventeen affirmative replies, they all acknowledged that it was a complicated problem to adjust the price on repair work, especially where work had to be taken apart, and a great many more of them expressed doubts of its practicability in a small shop where the principal part of the work was running repairs.

5. How do you set the piece price for an operation ? What is the basis ?

Recommendation in this matter was to have a close account kept on each operation, as performed by several different men who were considered competent, and the piecework prices based on the average less ten and twenty-five per cent.

6. After the piece price is set, do you limit the hourly earnings of the men, or do you let them make as much as they can at that price ?

About one-half of the answers to this were simply " no limit," while the rest stated that there is no limit while the price is maintained, but that if the average is shown to be too high there is a readjustment of the prices so that an average man will make fair wages, while an extraordinary man will make rather extraordinary pay.

7. What circumstances would render it advisable to change a piece price? Who should make the change, and should the men whom the change affects be consulted and advised the reason for such change?

This was very generally answered to the effect that where improved machinery, or changes of patterns and designs, enabled a greater amount to be accomplished, then there should be a readjustment in the prices, and the men should be advised and consulted with to enable them to show their side, and in some cases it is recommended the work be let out by bids from the men.

8. Do you allow all workmen piecework? If not, specify what classes are and what classes are not allowed piecework, and why?

This question was not answered very fully so far as the number was concerned, and there was such a diversity of exceptions that it would indicate but little uniformity in methods of different shops, some having abandoned the piece system on boiler work from the fact of there being so much opportunity to slight important parts in such a manner as to escape detection. Others excepted certain parts of the work in all shops on account of its being diversified. Some excepted helpers and apprentices, while others reported that all work is subject to piecework under detailed prices, and any one competent to do the work in a first-class manner has the opportunity of obtaining the job. In these cases it would appear that they have a bidding for all jobs of any extent.

9. When two or more men work together, how are the earnings divided? When a helper or an apprentice work alone, are they allowed full price for the job? If not, state why?

There appears to be a diversity of opinion in regard to this, so far as the apprentices and helpers are concerned, but the prevailing idea appears to be that unless they are on a job by themselves they should not receive piecework prices, unless it be where a job has been let to one party and he arranges to pay his assistant. The general recommendation regarding the divisions of the earnings is that each man should be rated by a daily wage, and the sum total should be prorated on this basis, taking into consideration the number of hours worked by each.

10. Should the Gang Foremen act as leaders and share in the earnings of the gang, or should they have an hourly rate? State your reasons.

It appears to be very generally conceded that in order to obtain satisfactory results under piecework system there must be close supervision, and the Gang Foreman should not have a pecuniary interest in either slighting the work or making unnecessary work; that he should be a director or inspector of work under either a daily or monthly stipend.

11. Do you have prices for all detail operations, or one price for the complete job? Which do you think preferable, and why?

The answers to this were to the effect that while there should be a price for the job complete, still, that it is necessary to have it in detail as much as possible, so as to provide for the changing of men, or increasing or diminishing forces while in process of completion.

12. Have you found any inferiority in workmanship due to the inauguration of piecework?

The majority think that piecework may for a while result in careless and inferior workmanship unless carefully guarded against. Some say that while this obtained at first, the evil was soon cured by careful inspection and a refusal to pay for the work until properly done.

13. Has the inauguration of piecework allowed the gradual introduction of cheaper labor on any class of work and so further cheapened the output?

The introduction of piecework has resulted in classifying the men and the work so that the best mechanics get the best work, medium men the medium work, while the rough work is done by cheaper men, and this has resulted in cheapening the output.

14. What effect has piecework had on the men themselves, i. e., on their training and general utility?

The effect on the men themselves relative to their training and general utility has been one of narrowing their capacity, as while we train them to become experts in one line of work, their interest and that of the company is to keep them in that one line, and their whole object is to reach the greatest proficiency in that one character of work, and while this has led to a greater sharpening of the wits to get up appliances and methods for such work, and where they work together to incite them to exact greater effort on the part of each other, still, this has the effect of narrowing their capacity, and unless a specific method of training is prescribed for our apprentices, it is doubtful if they will fully learn the trade and become proficient all-round mechanics.

From the foregoing, and from the fact that the value of any employe is in direct proportion to the amount and quality of the output resulting from his efforts, it is, in the opinion of your committee, the most just and equitable method of employing men, as by this means the man who is skilled and industrious reaps the benefit of all the energy and brains expended, and is not put upon a level with one of inferior capacity, or the time server, while both he and his employer receive just what was agreed upon, and if there is a spirit of justice in the setting of prices, there will be no hardship on either side, and these prices should be based upon the average, both as to men and conditions. Even on new work it would be remarkable if there was no variation in the output by the same man, and in repairs, especially where old parts have to be separated, there is a great variation, and in the opinion of the committee the setting of prices should have the same consideration that a competent foreman would give where there are no prices affixed. Such a foreman certainly knows just how long a man should be upon any piece of work, and, failing to obtain proper results, should call the workman to account, and it is in just the extent that a man's pocket is a more inexorable taskmaster under the piecework system than the average foreman, that we may expect better results than would obtain under a competent foreman who had the authority to base a man's pay upon the results of his labor. The averaging of pay has been one of the curses of the daily wage system; there has been no particular incentive for one man to excel another, and it has drifted into an average day's work for an average day's pay. Another thing under the wage system that about offsets the danger of a lack of thoroughness under the piece system, is the tendency to expend unnecessary labor on a piece after it is good enough for the service it is intended for. This, in our opinion, accounts for a large percentage saved under the piece system, as it is to the interest of the employe to stop when he gets through. If a man is so thoroughly proficient that he can turn out a great deal more work than any other, and by so doing receives much more wages than his co-laborers, there is no justice in reducing him to the average, even if he is the only one on that particular job in the shop, as the company pays no more per piece than it would pay to another, and, in case of a machine hand, obtains a benefit in the greater output of the machine. If we could increase the output of machinery or shops the twenty-five per cent claimed for this system and reduce our plants or increase our facilities that much, that alone would be quite an object, even if we did not get any benefit in the ultimate cost of the labor. This certainly would mean twenty-five per cent less time for equipment in shops and a saving all around; and as, so far as the committee is informed, this question is, "with but few exceptions," most heartily indorsed by those who have tried it most extensively, the committee considers that its investigation warrants it in most heartily recommending its adoption, and this is fully in accordance with the experience of those members of the committee who have had considerable to do with piecework.

P. LEEDS, Chairman,
WM. SWANSTON,
R. P. C. SANDERSON,
J. G. NEUFFER,
J. B. MICHAEL,
Committee.

THE PRESIDENT: Gentlemen, you have before you the report on Piecework in Locomotive Shops. What is your pleasure in regard to the report?

MR. BRIGGS: I move that it be received.

The motion was carried.

THE PRESIDENT: It is now open for discussion.

MR. MCCONNELL: Mr. Chairman, previous to seeing the report of this committee I had never been in favor of the piecework system in railroad shops, but when we come to investigate the manner in which all of the manufacturing establishments are carried on in this country, we find the system of piecework is universal. Take the iron mills, and the output is at the rate of so much per ton. In large foundries the price is regulated by the number of flasks a man puts up for a day's work. In the wheel foundries he is expected to put up so many wheels for a day's work. This is followed through in all of the contract shops where there is a similarity in the work. In the locomotive manufacturing establishments, like the Baldwin Locomotive Works, ninety per cent of their work is piecework. In the Schenectady find their class. The great incentive for promotion and better workmanship is regulated by the money earned; it encourages men to sharpen their wits to increase the wage rate; it prevents imposters; it reduces the percentage of attention on public comfort, reduces unproductive labor, increases the output of shops, regulates the time of operation. Daywork, it is understood, must be strictly separate from piecework; to obtain the best results men are required to work full shop hours, irrespective of quantity of money earned, report on piecework slip for office, the work performed and time employed on same, this to be indorsed by gang leader or inspector and foreman, then priced up in office by clerk who has the key book of prices. It is easy to detect fraud, and when discovered should be disciplined severely. Men are human, and when treated as men will serve the best interests of the company. I am so thoroughly in love with the system that I may be considered a crank on the subject. One thing I can assure the members: by good management the system will soon be decided as far superior to day service, and will require considerably less capital invested in tools and machinery to perform the same quantity of work, also will materially reduce the number of men required for daywork. Do not be controlled by other shops. Conditions vary, tools are different, rates of wages are not the same in all localities; but to have a model shop, good, willing and contented workmen, peace of mind to yourselves, and to save money for the company, adopt the piecework system, and you will live the longer for it, as you will have no occasion to dodge around the shops and call the foreman down because you discovered some one dodging around the corner loafing. [Applause.]

MR. BROWNE: There is one side of the piecework question which does not seem to have been touched upon, and which, to my mind, is at least one of the most important features of the whole system. It is the method of arriving at the price to be paid for doing the work. I feel that, in following the ordinary methods of determining this price, there is entirely too much approximation and guesswork, and that under these conditions there cannot exist in setting these prices the equity and justice, both to the men and the company, which should exist to produce the best results in the adoption of a piecework system. On the Pennsylvania System we feel that in this matter there is a question of equity between the company and the men, and which should exist in establishing a price, which will not only be to the benefit of the company in increased output, but to the benefit of the men in the shape of increased earnings, and in which arrangement, in a certain sense, the company shares with them the additional saving incident to the adoption of a piecework system. At Juniata shops 81 per cent of the work is done by the piece. The average rate received per hour for piecework, compared with the average rate received per hour for daywork, is from 12 to 18 per cent better in favor of the piecework system. When we started it at Juniata shops, the prices were set on the usual basis of observation of what a number of men could do on a certain piece of work, and as just conclusions as possible were drawn from this for the purpose of setting a price, making an allowance for a certain amount of personal interest the men would take, and the price established accordingly. This method is not always, as above stated, equitable for the men and the company at the beginning, and is subject to readjustment. This very fact would place this method of establishing a price open to severe criticism, it being largely a matter of guesswork, and therefore hardly fair to the men or to the company. This approximate method of setting the price is just as familiar to the men as to ourselves, and encourages in them a tendency to cover up, by not running to full speed or full feed their machines to their full capacity. For the last three or four years we have been endeavoring to cover this point from a somewhat co-operative basis, judging from the standpoint of capacity of the machine or the facilities provided for turning out the work, and working with the men to secure their interest, by explaining to them, as far as it may be advisable to do, the object we have, and removing from their minds the impression which the old method of setting the price carried with it, that you are liable to do them if they cannot do you. There should be some equitable reason which will appeal to the men as well as to yourselves in the setting of prices in a contract or piecework system as a basis for the permanent establishing of this system successfully. On the lines above stated we have been making for about six months a test in connection with tools, endeavoring to combine two things, and incidentally finding out what is the best speed and feed with a certain character of steel, and that which will do the best amount of work compared with its first cost, and in that way checking up feeds and speeds of our machines with a view of establishing prices based on the amount of material which can be removed in a given space of time. This is somewhat similar to what is known as the "Taylor" system. Of course, in making this test, we will also determine (and it is one of the objects of the test) the best grade of steel for doing the largest amount of work, assuming, of course, that the tool is a component part of the successfully operated machine. It is also our object to determine the economical limit of capacity of the machines, consistent with their cost of repairs and a certain reasonable length of life, it being true that in the interests of good economy of machine operation and maintaining in your equipment the most modern machinery, that these machines should wear out in a certain space of time to make room for others of more modern make and improved capacity.

One of the questions asked is concerning the sharing of the price paid for a piecework operation between the apprentice or helper and the machinist who may be working on the job. We have a class of young men under the age of twenty-one, who are too old to put at a trade, and yet who are frequently men in size and strength. These young men we frequently use as shop hands, and pay them a regular scale of wages, which, until they are twenty-one years of age, are less than the wages of regular men doing the same work. These young men are not, of course, called apprentices, and while acting as helper on a job for which a piecework price is paid they receive that proportion of the piecework price which their day rate bears to the mechanic's rate whom they are helping. We do not guarantee to teach them any trade, but at the end of every six months check up their record, which we keep, and move them to some other department, according to their ability, the object being to make special hands of them and give them such general experience as would best fit them for this end. An apprentice, when acting as helper, does not get a share of the piecework. They get their regular day rate, and their piecework earnings are shared between the company and the mechanic on the job. We feel that the mechanic is entitled to some compensation for the patience necessary for him to exercise with the apprentice as a helper. Mr. Hill spoke of the helper charge and its reduction, referring to that class of labor which is ordinarily charged into expenses and prorated on the output in the form of percentage. In our machine shop, to a certain extent, we have provided in the piecework price an amount to cover the cost of handling material, and which cost would otherwise be charged directly to expenses, calling the men who do this work "shop hands," and letting them handle the work on a piecework basis. These men constitute a definite force provided for this purpose, and are almost entirely on a piecework basis. Under this arrangement, the labor is identified directly with the work and not charged as a percentage on the output. In our boiler shop, where we do tank work, boiler work, frog and switch work, there are no laborers excepting the two sweepers. All the handling of material required in connection with this work is on a piecework basis, and a certain definite number of men classified as shop hands do this work, and earn from 13 cents to 14 cents an hour. This method has reduced the cost of handling material on our boilers alone something like thirty per cent.

Mr. Gillis: I have been interested in piecework for a number of years. The first piecework I ever had was about fourteen years ago. I remember very distinctly some things that happened at that time. For example, take the case of a man who was working alongside of me on a press lathe. He was getting ready to quit his work. A month before he quit he worked that machine away beyond its capacity; he worked himself away beyond his capacity. The result was, that he made about $140 for his month's wages. The result was there was a parallel cut in the whole business and in the work of that machine which brought it down to something like $70, about fifty per cent reduction. The next man who came to work on that machine found that he could not make a living at it at all, try as hard as he would. Investigation afterward proved that the work which had been put on the shelves which the man who had quit had done, practically had to be scrapped — it was not of any use whatever. There was a lack of careful inspection of his work. It was also proven that the machine was badly out of order and had to have extensive repairs. I simply state this as a particular case against the wholesale reduction of price. I do not think there is any one thing which requires more care than piecework prices, because we should try to be perfectly fair.

I heard the question asked about the handling of the apprentices with the piecework. Our system has always been this: We prorate the earnings between the apprentice and the mechanic; that is, if the mechanic is a 20-cent man and the apprentice a 10-cent man, the apprentice would be credited with one-third of the earnings and the mechanic with two-thirds. The apprentice, however, is not paid the one-third, but is simply paid as a day worker at his apprenticeship rate. In other words, the above division is made to determine the mechanic's proportion. This system works out to the advantage of the company, the mechanic and the apprentice, as it is to the interest of the mechanic to get all of the work possible out of the apprentice and to instruct him in proper and quick methods of work, and some of our apprentices actually perform in a short time as much work as the mechanics themselves.

I remember another case that occurred in a shop I had charge of. I had made some reductions in prices. I went over them very carefully, and when I went over the prices I did this invariably with every price. I did not sit in my office and say this ought to be so and so and that ought to be so and so; but after investigating the thing as closely as I could I made up my mind what was the fair price for that work, and then I called in the man who was concerned and I said, "Here is what I think is a fair price on that work." It might be a considerable reduction — it might be as much as fifty per cent. And I said to him, "If you have anything to say about that, say it," and I would let him make his case just as strong as possible. And then, when he got through, I would decide what was fair and right.

With regard to piecework on boiler work, I am not in favor of it. I do not believe in it. I believe if there is any one part of our locomotives that we should be especially careful about and ought to be willing to pay a little extra price for, it is boiler work. I do not believe we can do it too well. If the boiler work is good at the outset we will save a good many dollars and cents to the company.

Another question Mr. Browne brought up was a question as to the prices on various machines. That is an important one. I think that every machine ought to have a piecework price for that particular machine; or, in other words, we ought to give the man the benefit or take the benefit ourselves, whichever the case may be, of the machine. In one case we may have a job on a certain machine which costs us, say, 35 cents. We put in another machine which is better, or possibly we overhaul that machine thoroughly and improve it, and we can then make the price on that improved machine. You cannot set a certain price for a certain job without also taking into consideration just exactly how that job is going to be done and all the facilities the men have for doing it. The question comes up in regard to the helper and the piecework. I have tried that in two ways. One is to pay the helper his pro rata of the price; that is, if the helper is a 15-cent man and the mechanic is a 25-cent man, the helper will get three-eighths and the mechanic five-eighths of the price. The other way is to simply pay the mechanic the piecework price and pay the helper the daywork price, but giving the piecework helper a higher rate than the daywork helper's rate. If he is a 13-cent man, give him a 15-cent rate. If he is a 15-cent man, give him a 17-cent rate.

Another thing I would call attention to is, that before you start the piecework system it is absolutely necessary to have a perfect check, if such a thing can be had, on the work; that is, the quantity of work that you give out to be done and the quantity of work that is brought back to you. We all know that it is pretty hard to watch a shop all the way through, and I have found that men, for example, working on brasswork, will spoil some work. The result is, if you do not watch them closely they have a friend over at the foundry, and he will slip in a flask, get it out for him, and the pieces he will spoil will get in the scrap. You may detect it and you may not. But in our shop we lock up our work in the rough. We give a man so many pieces in the rough and expect him to return so many pieces finished. To my mind that is one of the most difficult things in the piecework system in the erecting shop. I think it is a very hard thing to work out satisfactorily. I do not think I have ever done it myself, but I think one of the things we have got to guard against is this: that if a man has got a piecework price for new work or for renewal which is a better price to him than the price he gets for repairing the same article, if he can possibly do it he will renew that article every time. Now, there is a big expense right off. I think in setting prices for renewals and prices for repairs, the price for repairs ought to be a better price to the man than the price for renewal.

MR. HERR: I have been very much interested in Mr. Browne's remarks, and I notice from his remarks on boiler work that he thinks, or at least he gave me the impression, that piecework is apt to be poor work, at least a poorer quality of work than daywork. It seems to me that is a very serious admission, if it is a fact. I would like to hear a little further on that point. It is very important that we get good work, and I would like the gentlemen who have had a larger experience than I have had to say whether it is not possible to go on piecework and still be sure that you are getting good work.

MR. BROWNE: We have made two exceptions in our piecework system as applied to boiler work. One of these exceptions was made when we first started and one recently. The first was in regard to flue work, putting flues in the boiler, in which case we found there was a tendency to hasten it, and unless the man in charge was present to watch every flue as it was put in, the results in the quality of the work was liable to be in question. We do not mean that there was a tendency to be dishonest, but we do mean that in all piecework it is more proper and necessary to watch the work than to watch the men, and it is usually the opposite in daywork. Unless you can watch every stroke of the hammer or every movement of the roller or expander, you cannot be sure that flues are being put in exactly as well on a piecework basis as on a daywork basis. It is also true that the cost of this kind of supervision will frequently more than offset the economy incident to the adoption of a piecework method for doing this work. It is quite true that this work is subject to supervision in any case, but it seemed advisable to remove the element or tendency to turn out quantity at the expense of quality, the absence of this tendency, in our minds, being one more obstacle removed which might interfere with good work; and as flue work is one of the most important things in connection with the successful boiler, we thought it proper to keep it on a daywork basis, at least that portion of it which applies to the putting in of the flues in the boiler.

The other exception, and which was recently adopted, is the riveting. In the absence of automatic devices for securing the best results in this direction, the length of time the sets should be held against the rivet after it is driven in the boiler would vary somewhat, and when the pressures to be carried in these boilers when complete are high and the machine is somewhat close to the limit, everything that can be done to secure absolute tightness and immovability in the rivet after being driven must be taken advantage of. We have had some considerable experience with heavy shell boilers carrying high pressure, and in driving these rivets we found there was a tendency, where this work was done on a piecework basis, paying so much per hundred rivets driven, to pull the sets off too soon, and that considerable of the trouble with the shells was due entirely to that, and decided that this also should be removed from the piecework schedule. To overcome any carelessness, we have established a penalty for every rivet that is not driven tight or properly; the gang of men who drive the rivet practically pay the company so much for each and every defective rivet. On the same boilers, with the same men and the same material in the rivets and the same method of heating, with nothing changed except from piecework to daywork, where we had from eighteen to twenty rivets in a boiler that would leak because they had not been held up long enough, the boiler which followed the change from piecework to daywork had only three rivets which leaked, and succeeding boilers, in many cases, none at all. Concerning the preference of daywork for riveting, I would also say that a leaky rivet, or a rivet not driven properly, is not always found, nor can it always be readily found in the boiler shop, frequently not being discovered until the boiler is mounted on the frames and tested. The delay incident to the removal of a rivet under these circumstances not only is somewhat serious, but it would frequently cause considerably more expense than the saving incident to the adoption of piecework over daywork for the driving of rivets. In similar manner to flue work, we feel that from this operation on boiler work should be removed every chance or tendency to hasten the work at the expense of quality, and that it is cheaper in the end to pay even quite a considerable amount more on a daywork basis for driving the rivets in a boiler, and have them properly driven, than to adopt piecework at a lower price and pay the cost of removing defective rivets after the boiler is mounted on the frames.

All of the other operations on our boilers are done piecework, and are of such a character that supervision incident to close scrutiny of the work, and which is necessary in carrying out piecework, is not excessive in cost.

In connection with the flue work I would say further that all of the operations on our flue work, except the putting of the flues in the boiler, are done on a piecework basis, and we feel safe in this matter, for the reason that they are subject to easy inspection. In building our boilers we follow a system of templets, and which enables us to make up all of the material, sheets, etc., for ten or twenty boilers at one time. There is no opportunity to get away from these templets, unless a man may deliberately punch a hole wrong, and which, of course, will some time happen. The sheets are not specially marked, and any sheet will do for any boiler of the same class.

You can apply a piecework system to almost everything after proper thought, but piecework applied to everything is not always advisable, in my judgment. What I mean is that, while any operation which you choose to so do can be done on a piecework basis, or a contract basis, it is sometimes true that the cost of supervision, the costs of making good defects which are not apparent at the first completion of the work, but show up in process of service only, are far more in amount than the economy or saving due to the adoption of piecework over daywork for that particular operation.

All the caulking on our boilers is done piecework, and it includes all the caulking necessary to make the boiler tight and satisfactory, not only the first caulking which is done in the boiler shop, but such additional caulking as it may be necessary to do during or after test of the boiler. Water pressure is put on and the various leaks indicated. The pressure is then lowered to a comparatively small pressure and the men required to caulk the boiler until it is perfectly tight and will hold this pressure satisfactorily. If they do not perform the operation in the first caulking in the boiler shop thoroughly, it only makes more time necessary on the second operation at time of test. The price paid for the caulking includes all the caulking necessary, whether in boiler shop or in erecting shop after test or during test to make the boiler tight.

Mr. Herr: It seems to me that the admission that there is any job in the shop that cannot be done by piecework successfully without endangering the quality of the work is a serious argument against the piecework system. If the riveting cannot be done satisfactorily on the piecework basis, there is other work necessarily that perhaps is not as important as riveting, and of which the neglect will not be as marked in its effect, but nevertheless, it will be susceptible of neglect, and it weakens the whole system. I cannot see wherein the riveting differs from the rest of the work, and I would like to inquire why it is not a feasible thing to make the riveters replace these leaky rivets on their own time; make their piecework job price for perfect work and make them replace all the leaky rivets. Would not that be a solution?

Mr. Browne: That is exactly what they have to do; but it costs a certain amount to get the rivets out; that they have to pay the expense of.

Mr. Herr: But you put it on daywork?

Mr Browne: No, that is piecework. We pay so much a rivet for getting out, but they have to replace those rivets in their own time.

Mr. Hill: In the early stages of my practice in the piecework system, I had an idea that we could not successfully work piecework on boiler work. But my experience is this: We do not want any day's work of any description in the boiler shop. My experience is that we have got better work on the piece price basis. Of course, there must be a penalty for poor work, and the men are very careful not to have that penalty imposed on them. I must say that I have been very successful with piecework on boiler work, especially on repair work.

Mr. Deems: I fully agree with what Mr. Herr has said, and also with Mr. Hill. It does seem to me a matter of great regret that riveting and putting in flues must be made an exception to the piecework system. Now, in my experience, especially in the matter of setting flues — that is, in putting in new flues — I have seen no trouble whatever in establishing piecework prices and having it carried out successfully. I have had all the flue work done in that way for some time, with the exception of caulking flues in the roundhouse in running repairs. I am free to confess I have never been able to see my way clear to putting that on the piecework basis. You do not know just what a man does in a fire box. You would have to have another man watching him if you attempted to establish a price, and that is one of the things, and about the only one, that I found necessary to except from piecework prices. Even in roundhouse running repairs, I found it quite easy to fix piecework prices for all that work, and I found it equally satisfactory to the men and to the company, and I want to say that I believe that any piecework system that is not equally advantageous to both the men and the company, is a failure. I think that is the secret of successful piecework. I was talking this morning to a gentleman who had some experience in England, where they have been working piecework — on the Midland Road, I think — for some twelve or fifteen years, and he says that the men there are the strongest advocates of piecework — more so than the company, and I believe that must be true at any place where piecework is entirely successful. I think the first thing to do in establishing piecework is to go at it somewhat slowly and attempt to develop a sentiment in favor of piecework among the men — educate them, so to speak, get them to thinking about — and get them to think about it rightly before the piecework prices are set at all. I am unable to distinguish between the system that Mr. Browne speaks of in establishing the piecework prices and the system that he objects to. If you take the work of six or eight men on a given operation for a given number of times, assuming that they are putting forth their best efforts, and also assuming that the machine is doing work to its utmost capacity, or to a reasonable capacity, you are certainly attaining just the results that Mr. Browne speaks of, if it is followed out carefully, and I am unable to see where there would be any particular advantage in attempting to establish the piecework prices on the output of a machine in the way that he speaks of over the ordinary method. I may be in error on that point.

Mr. Swanston spoke of making a reduction from the daywork price of about ten per cent. I would like to ask him if he did not find that a reduction of ten per cent really resulted in a much larger saving than ten per cent?

MR. SWANSTON: Yes, sir.

MR. DEEMS: That has been my experience. I believe that a company can afford to take the price of the men by day's work and establish the piecework at that figure, and then save something.

MR. SWANSTON: That is correct.

MR. DEEMS: This is a question of taking up what you might call the lost motion between the jobs, so that the reduction of ten per cent in an actual operation means a good deal larger saving than that to the company.

MR. SWANSTON: About fifteen per cent.

MR. DEEMS: That is my experience, exactly.

MR. SWANSTON: I would say, Mr. President, that so far as boiler work is concerned, we have never, in boiler work proper, established piecework. I have felt that there was a little possibility of slighting the work, especially in putting in braces, and so forth. But so far as flues are concerned, I have not for ten years put in a flue that was not done by piecework, and I think very successfully. The men who put in flues do it by the piece for the whole operation from beginning to end, and they are entirely responsible. If any flues leak, they replace them for nothing, and that is carried out until the engine has been tried and has made a successful trip over the road in regular service. There is no trouble about running the flue business.

MR. MACKENZIE: I would like to ask a question which I have not heard brought up here. Is there any difficulty or clash between the producing and finishing shop in this piecework system? For instance, if the blacksmith shop is the producing shop, and the material is taken into the finishing shop—whether there is any clash between the men as to the amount of material?

MR. SWANSTON: I would say in regard to that, objection is made by the men if the work that comes from the blacksmith shop is not up to the average standard. They will object to having to remove so much stock. The same way with material coming from the foundry—if it is too hard, or if there is too much stock, if the pattern is wrong—objection is always made, and this tends to improvement in the foundry.

MR. LAWRENCE: I am rather inclined to side with Mr. Gillis about boiler work, judging from my experience. We have had to make repairs on boilers that were built in what we may term two of the best railway shops in the country that build new locomotives. In both cases we had to practically remove the mud rings altogether from both those boilers, or rather from the boilers of both builders. They were put together by piecework. We had to knock out every rivet and take the mud rings out. You could not find three holes in succession that were fair, and some of the rivets in the mud rings were of the shape of the letter "S," and it didn't take any driving to get them out. As soon as you cut the head off, you could push them out with a lead pencil. That has been my experience, which I can substantiate to any person who wishes to know further about it. This system of piecework may be very well in a large shop, but not in a small shop with very crude facilities. In the mud rings in question I had to ream out every hole to the next size larger rivet. I do not see any serious objection to piecework where you can get the work done right; but as Mr. Gillis says, a boiler is too important a thing to slight in working. It costs too much to fix up these bad jobs. I am connected with a small shop, and while I have not taken up the question of the cost of doing individual jobs by daywork in the locomotive shops, I have in the car shops. I have compared the piecework prices of one of the large car shops in this country. I have a card which is filled out for every operation on freight car repairs, giving the cost from the list of piecework prices, and giving the cost of the work in the daywork shop. I am free to state, and I think I can substantiate it by figures in some cases, that we have often beaten the piecework prices; in other words, have done the work for less money by daywork. In other cases it has cost us more. Now, if you take the amount of money that is expended to organize and perfect and maintain a piecework system in a shop, the additional clerical work, and put that on to your men's wages for day's work, and in addition to that get good, proper supervision over each department, weeding out your drones, I will take my daywork system against your piecework system every time.

On motion, the discussion was closed.

THE PRESIDENT: We will pass on to the next subject, "Motors: Steam, Air and Electric." Mr. McConnell is chairman of the committee.

REPORT OF THE COMMITTEE ON MOTORS—STEAM, AIR AND ELECTRIC.

To the President and Members of the
American Railway Master Mechanics' Association:

Your committee begs leave to report sending out the following circular:

The Committee on Motors—Steam, Air and Electric—would thank you for the following information:

1. In your shop practice do you use any of such motors, and how many of each?

Steam.. Number..
Air .... Number..
Electric .... Number..

State how many horse-power of each.

State class of work used on.

2. What design of air motors do you use?

3. What design of electric motors do you use?

4. What design of steam motors do you use?

5. State cost of each?

6. Which do you find the most economical and effective, and which the most convenient?

7. What are the principal items of repairs to such motors?

8. In steam and air motors, what pressure do you carry?

9. In fitting up a shop, which class of motors would you use? Please give reasons for adopting any one class.

10. What data can you furnish regarding cost per horse-power when electric, air or steam motors are used?

11. What class of work do you consider each type of motor (air, steam and electric) best adapted for, and what is the relative convenience and economy?

12. When using motors, is it your practice to shape the cutting edge of the drills, reamers, etc., different from shapes used in ordinary practice?

13. Do you use air, steam or hydraulic riveters?

14. What advantage is there, if any, in the use of hydraulic riveters over steam or air?

In addition to the above information, the committee asks that you kindly give answers to the following questions, as it is desired to get this in detail as much as possible:

1. Give difference in cost of drilling, tapping and putting in stay bolts with motor in fire box, as compared with old method.

2. Give difference in cost of rolling one hundred 2-inch flues with motor as compared with old method.

3. Give cost of facing valve seats and milling out ports and boring out cylinders as compared with old method.

4. When shops are equipped with dynamos, is the electric motor preferable to steam or air motors ?

5. What saving, if any, is there where electricity can be tapped through a meter from an established power plant at a certain cost per ampere, as compared with the cost of maintaining and running an electric equipment in shops ?

6. What machine would you recommend to run independently with motors, and what advantages would be gained by so doing ?

7. In drilling, tapping and reaming with motors, have you found it necessary to change cutting edges of tools ? If so, please furnish blue prints showing different styles.

8. State any other work performed at your shops, not mentioned in above questions, and relative convenience and economy of using motors for such work.

1. Do you use compressed air in and about shops and yards ?

2. Give list showing purposes for which it is used.

3. How is the pressure obtained ? By compressors or air brake pumps ?

4. Give type and make of compressor, and capacity in cubic feet of free air per minute.

5. If more than one compressor, give capacity of each.

6. Do you reduce this pressure for any particular work ? If so, state nature of work and pressure used.

7. What steam pressure is used to operate compressor or pump ?

8. What size pipe is used for conveying air to different points where used ?

9. About how much storage capacity have you in the way of receivers, and exclusive of pipe line ?

10. About how many feet of pipe line ?

11. Do you reheat the air after it has left compressor and before it is used at motor or tool ?

12. If so, state manner of heating.

13. What data can you furnish regarding benefit obtained from reheating ?

14. What data can you furnish regarding the cost of compressing 1,000 cubic feet of free air ?

Replies should be sent to the Chairman of the Committee, Mr. J. H. McConnell, care of Union Pacific Railway, Omaha, Neb., before March 15, 1897.

Replies were received from twenty-four railroads and one locomotive builder, reporting thirty-six steam motors, one hundred and seventy-two air motors and two hundred and twenty-nine electric motors.

The Baldwin Locomotive Works reports in service twenty-seven steam motors, forty-one air motors and two hundred and twenty electric motors.

Two railroads report nine electric motors in service.

Five roads report no air or electric motors in service. In a few instances motors are used with steam and air. Horse-power varies from 2½ to 10 in air motors, and from 10 to 50 in electric motors. Design of air motors, both rotary and piston.

In steam motors reference is made to stationary engines for driving shafting and isolated machines.

Cost of air motors varies from $100 to $150.

Eighteen roads using air motors consider them the most economical and best adapted to the work in shop practice, and at the same time report no experience with electric motors.

Air pressure reported shows: One road uses 40 lbs., one 60 lbs., four 70 lbs., one 75 lbs., four 80 lbs., two 90 lbs., four 100 lbs. and one 115 lbs.

In answer to question No. 9, the following replies were received:

Consider air best for portable drilling, tapping and reaming, account of greater convenience and less danger.

Would use principally air motors and electric motors.

Would use electric motors, account most convenient, cleanly, and permits overhead cranes to handle work; electric for machine tools where overhead cranes are used, and air in boiler shop.

Would use all three in their relative field of usefulness.

For all extensive shops, electric motors for traveling cranes; for lifts, compressed air.

Air motors with fewest parts, hence economy.

Air motors in railroad shops, account variety of uses air can be put to.

Electric motors, account more uniform speed.

Air motors for small shops. For complete installment would combine electricity and air.

Would use air, as it can be used at any place where steam can be had.

Air, for reason that it is the cheapest.

Air motors where portable motors are used; consider air preferable to electricity, as motors can be used with either steam or air; as the ordinary mechanic is more familiar with them they can be looked after and repaired more readily than the electric motors.

No definite information is given as to the cost per horse-power in the use of electricity or steam.

In regard to the class of work each type of motor is best adapted for, nine replies were made.

Electricity by a majority is considered the best for overhead cranes for heavy work, and air hoist for machines; air for drilling, tapping and reaming about locomotives; air for boiler work.

Where motors are used, there is no difference made in the shape of the cutting edge on tools.

One shop reports the use of air in riveting machine.

Two shops use hydraulic and air riveter.

One shop uses steam and air riveter.

Four shops use hydraulic.

Three shops use steam.

Where hydraulic riveters are used they are considered better than air or steam for solid work. Air is considered better for light riveting.

The cost of drilling, tapping and putting in stay bolts in fire box with motors shows a saving of 25 per cent to 75 per cent.

Two roads report a saving of 75 per cent by this method.

Five roads report 50 per cent saving.

Two roads report 25 per cent saving.

Cost of rolling one hundred flues with motor compared with old method by hand; replies are made by four roads:

One reports a saving of 25 per cent.

One reports a saving of 50 per cent.

One reports a saving of 100 per cent.

One reports cost rolling flues in fire box and front with motor at $1.68; same work by hand $3.15.

Cost facing valve seats, milling ports and boring cylinders by air motor is not given, but saving is estimated at 50 per cent.

Where shops are equipped with dynamos, four roads consider electric motors preferable to steam or air.

Four roads consider air preferable to electricity.

One road considers electricity best for heavy work and air best for light work.

No information furnished as to saving where electricity can be tapped through a meter.

Six roads recommend that such machines as are very heavy or are run but a part of the time be operated with independent motors as a means of economy.

Two recommend operating driving wheel lathes, heavy planers and slotters with independent electric motors.

The committee finds a lack of data as to the relative cost, from a practical standpoint, per horse-power where these machines are used. It also finds the information absent where only one kind of a machine is used. This is particularly true of air appliances, presumably on account of the different conditions that would necessarily have to be considered, it being practically in its infancy, as it is only in the last four or five years that it has been recognized as an important factor in all well regulated shops.

The following are some of the items compressed air is universally used for in connection with suitable appliances, with an average of from 25 to 50 per cent economy over the former practice:

Tapping out stay-bolt holes; screwing in stay bolts; reaming and drilling holes; chipping and calking; removing tires; beading flues; air hoists, vertical and horizontal; and for all purposes including foundry and ice house elevators; jacks for raising cars, trucks and locomotives; telescope jacks used in connection with drop pit for dropping drivers; press for forming tinware of every description; presses for general machine shop use and pressing in bushings, driving brasses, etc.; large boiler punches; shears, erected and used outside of shop for the purpose of shearing off test coupons; punching holes that would otherwise necessarily have to be drilled, as the ordinary power punch and shears is not of sufficient gap for the large sheets now going into general use; tank riveters; stay-bolt nippers and pullers; light stationary air hammers in blacksmith shop, made out of Westinghouse brake cylinders, to be used at tool dresser's fire or where general light work is done; shears at scrap pile for cutting up old bolts to standard lengths, and hammer for straightening; shear for light sheet-iron work, made from Westinghouse cylinder at minimum cost; feed for upright nut-tapping machine, allowing operator to handle six taps; also drilling safety holes in stay bolts before being screwed in fire box; machine for centering all bolts before turning; Westinghouse cylinders to operate vises without screw; by the operation of air, apply couplings to and remove clamps from air hose; also the same appliances for operating a knife to cut off old hose from nipples; sandpapering machine; small Pelton wheel for operating small emery wheels; for sharpening tools in convenient places through the shop; blast for blacksmith forges; Westinghouse engine operating large transfer table; applied to mixing paint in large quantities by putting a pipe in the bottom of a barrel; used in all kinds of motors for boring cylinders and facing valves; grinding steam pipes; driving any special machine when line shaft is not running; cleaning out flues; in connection with gasoline for removing tire; cleaning cushions and carpets in and out of cars; blowing out cylinders before applying packing; testing stay bolts; also to move engines to other locations; for different purposes, such as painting, bending pipe, operating letter press, rolling flues, swedging flues, testing brakes, painting cars, sanding roofs, bridges and depots, and several other purposes.

Your committee is decidedly under the impression that both air and electricity are an advantage over steam for portable motors, and also there are conditions existing where the electric power is preferable for large permanent motors via line shaft, for driving large tools, and where a convenient operation of an overhead crane is desired. Leaving the latter out of the question, however, where a line shaft can be conveniently operated with a well designed stationary plant, your committee is under the impression the latter is the more economical.

For small portable tools the air motors are no doubt more convenient, if not as economical. As the committee is unable to gather any definite information based upon practical results that would assist us to establish that fact, but considering the danger of electricity which exists to some extent at least, and then considering the convenience of air in and around the shop and the fact that any ordinary mechanic can repair, look after and handle air motors, the relative difference would have to be considerable to make the former preferable; however, the power-transmitting capabilities of each in combination with their other individual and peculiar lines of usefulness opens for them a distinct and separate field in which neither can be substituted for the other; therefore, it is well to anticipate the possible requirements for other than the transmission of power before coming to a final conclusion.

It seems to be certain that power may be transmitted by compressed air for a considerable distance with less loss than by any other known means. This, understand, is not figuring from the moment compression ceases, as there is an inevitable cooling of the air at that time with its necessary loss, but this figure to be taken after it has assumed its normal temperature, when its loss from any considerable distance is practically nothing.

The capacity of storage reservoirs is also an important item. They should be of such capacity as, under normal conditions of consumption, would enable the air compressor, after the first charging — which in a big plant can be done before working hours in the morning, if necessary—to keep up the required pressure by being run at a moderate speed.

Much is gained by the reheating of compressed air, but it should be done immediately before entering the machine where this work is to be performed to get the full benefit to be gained in expansion. The committee has not been able to obtain any definite information, however, as to what per cent of economy will be realized, or whether any practical device has been gotten up for portable motors now in use for this purpose, but it believes a simple arrangement can be introduced on stationary motors with very satisfactory results.

For general railroad work, with the exception of special cases and conditions as enumerated, a well-designed air plant will be the most convenient and economical, all things considered.

A shop turning out sixty engines per year, with general repairs, has been equipped with an air plant consisting of one compressor, 15-inch steam, 14-inch air and 18-inch stroke cylinders; five ice house elevators; one hoist for driving wheel lathe; six hoists for lathes and planers; two brotherhood engines; three motors; one pneumatic hammer; one plant for testing air brakes; one sand elevator; one fire kindler; one flue cleaner.

The cost of above compressor, including foundations and pipe connections, was $1,260.50. Pipe lines, hose, valves, reservoirs, motors, hoists, elevators and other appliances, $1,189.50. Total, $2,450.00.

On a test run of eight hours, it required 313 pounds coal per hour, or 2,508 pounds for the eight hours' run.

It required five minutes and forty seconds to raise pressure from 0 to 120 pounds. Compressor made 838 revolutions and compressed 2,681.6 feet free air to 193.9 feet at 120 pounds. It requires with this compressor 20.4 pounds coal to compress 1,000 feet free air to 120 pounds, showing 60 per cent of its theoretical efficiency. As the compressor has been in service eighteen months, an overhauling of the cylinder packing and air valves would probably produce a higher efficiency.

Compressed air is one of our most useful and most abused agents. It is used in our shops and yards in a very extravagant and wasteful manner. Small leaks are allowed to exist, valves allowed to blow a little, hose couplings leaking, motors from wear consuming an excessive supply of air, each in themselves a small item, but in a large plant collectively amount to a large waste, causing increased service from the compressor and increased consumption of coal. When we treat our air plant in the same manner as a steam or an electric plant in regard to stopping the small leaks, we will reduce the cost of compressed air and add to its efficiency.

J. H. McCONNELL, Chairman,
JOHN PLAYER,
W. C. ARP,
WM. RENSHAW,
V. B. LANG,
Committee.

MR. McCONNELL: Mr. Chairman and Gentlemen,—This report has been before the convention for some time, and in the hands of members of the Association for some two weeks. It is not necessary, therefore, to go through the report, but I wish to call your attention to a few points. The committee is decidedly under the impression that both air and electricity are an advantage over steam for portable motors — that is, for small portable tools the air motor is no doubt more convenient, if not more economical. Another point is, the capacity of the storage reservoir; and another is that, for general railroad work, with the exception of special cases and conditions, as enumerated, a well-designed air plant will be the most convenient and most economical, all things considered. We have been able to get very little information in regard to electricity, but have obtained some information in regard to the size and speed and cost of electric motors that could be used for shop practice. Electric motors are manufactured from 1¾ horse-power up to 50 horse-power for shop purposes. A 1¾ horse-power motor costs $137.50; a 3 horse-power motor, $167.50; a 5 horse-power motor, $236.25; an 8 horse-power motor, $292.50; a 10 horse-power motor, $367.50; a 15 horse-power motor, $467.50. The speed of the motors is: for the 1¾ horse-power, 1,800 revolutions per minute; for the 3 horse-power, 1,800; for the 5 horse-power, 1,700; for the 8 horse-power, 1,600; for the 10 horse-power, 1,350; for the 15 horse-power, 1,200. The maintenance of these motors is said to be about two and one-half per cent of the first cost. The cost of operation under favorable conditions after the plant is set up, is about $120 per year per horse-power, for isolated plants of 100 horse-power and under. Where the motors are rented and power furnished, the cost is from $25 to $50 per horse-power per year where coal can be obtained at a moderate price, and the power plant is operated by compound condensing engines under favorable circumstances. To equip a shop with six motors from 1¾ horse-power to 15 horse-power, and one 50 horse-power generator, the costs would be: for motors, $1,668.75; for the generator, $1,100; a total of $2,768.75. This does not include setting up or wiring. It is reported that the principal item of repairs to motors is for brushes and the turning up of commutators.

THE PRESIDENT: Gentlemen, you have heard the report of the committee on motors, together with Mr. McConnell's remarks; what will you do with it.

On motion of Mr. Henderson, the report was received and opened for discussion.

MR. MITCHELL: I have read the report of the committee with a great deal of interest. I will state that we are large users of air motors through our shops, and we encourage each shop to introduce air motors where possible to facilitate the work. But I found it necessary to caution our shops in one particular, and that is against putting in air motors and hoists, for doing work, when the work could be done cheaper by hand. In other words, over one drill press — where we are prepared to do large work as well as small — I saw the mechanic take off a cylinder head from the drill press table with the air hoist when it could be done much quicker and easier by hand. That is, of course, one feature of the question that by watching can be controlled. We also find the air motor exceedingly beneficial in our bad-water districts in beading the flues or rebeading the flues when needed. Where the beading was formerly done by hand, in the roundhouse, we found that the flues might run two or three days before they required beading again — or rolling, I should say, again — with the pneumatic hammer, and using a small amount of air at low pressure, we could get a uniform blow which would enable us to run the flues much longer between rerollings.

Another thing I notice is, that the report states that air is used a good deal for forcing in bushings. In my judgment, air is not a reliable means for applying bushings in rods and driving boxes, because air is elastic, and if the bushing sticks a little the air will compress and the bushing will be retarded at one instant and it will jump the next — the speed at which it goes into the driving box is not uniform, and for bushing purposes I certainly recommend hydraulics, as the water will not compress.

There is one point that has been touched on by the committee and recommended, and that is that the air be reheated before it is used in a motor. I think this is one of the most important things that could be done so as to get better economy from the air.

A combination of air and hydraulics has been used in many machines very successfully; the compressed air to drive the ram to its work and then the hydraulic pressure doing the work. That has been demonstrated to be very successful.

Mr. Barnett: I would like to emphasize Mr. Mitchell's remarks on the point of reheating air. Trying to get some information from other people as to their use of small shop motors, I find that every place that I visited treated the matter of utilizing air power apparently as a dynamic matter; whereas, it seems to me that the question is one of thermo-dynamics, and very few realize how simple the operation of rewarming the air is when you use a reciprocating motor.

Of course, if you use a rotary motor — I speak now of motors for drilling, tapping, reaming, boring cylinders, facing valve seats and that kind of thing — if you use a rotary motor, practically you cannot gain any advantage by rewarming the air; but in the reciprocating motor it can be done. For instance, use a motor of 3½ inches diameter with 6-inch stroke of the vertical or steam hammer type; you can coil a ⅝-inch copper pipe about four turns, inclose it in a tin casing, put a common tin lamp inside it, use two ⅞ wicks in your lamp, and a pint of oil will run that motor for thirty hours, giving you excellent results for a small expenditure in fuel. The rise in temperature of the air entering the motor is quite perceptible, and if you are working the motor in a cold climate, such as has been most of my experience, you find it a great advantage in getting rid of the formation of ice, because if you do use the air expansively, you are always liable to choke your passages with ice or snow. Perhaps a simpler form of making a reheater is to cast a hollow cone of bronze or brass, and put your lamp inside of it. That is scarcely so effective as the four complete coils of copper pipe.

I would like to ask a question: Using the pneumatic riveter for tank work, have the members of this Association found it a clear advantage? I have used a riveter, and the increase in the time and labor given to calking the tank, especially at the lower joint or the joint with the flooring plate, was so much that there was no gain. It seemed that the rapid action of the pneumatic riveter left the rivet too hot. You see, the rapid action really warmed the rivet rather than allowed it to cool, so that when the man took the riveter away, he left that riveter a little too hot, so that the plate really stretched the rivet instead of the rivet drawing the two plates together. The rivet will draw the plate, if you drive it fairly cold, but if you drive the rivet too warm, it will not. When at Newport News shop yard yesterday, I noticed that on the hulls of the men-of-war there under construction, they were using both electric motors and pneumatic motors in charge of colored labor, drilling. Just from a superficial examination of the work going on it seemed to me that the pneumatic tool was the more efficient and more easily handled, especially with such labor as they were there using.

MR. MITCHELL: In answer to Mr. Barnett about tanks, I will state that we make all of our cisterns for tenders under the pneumatic riveter. We do no calking whatever on our cisterns. We make an angle iron run-around for the top and bottom. Against that angle iron we put tar paper; then the sheet against that, without any preparation except cutting from the shears and punching, and then use the pneumatic riveter. No calking whatever is done on the tender. We have followed this practice for years, and I see no necessity for calking tenders. We have no leaks, and our apprentice boys are doing the work.

MR. BARNETT: May I ask Mr. Mitchell if the pneumatic riveter is the single squeeze or the pneumatic hammer with the numerous blows?

MR. MITCHELL: The single squeeze.

MR. BARNETT: That makes all the difference in the work.

MR. TONGE: We have not calked our tanks for the last six years. We use the tar paper, as stated by Mr. Mitchell, and in no case have we found it necessary to do any riveting after the tank is finished — no matter whether it is for repairs on the tank, or whether it is a new tank.

MR. MITCHELL: I might further add, that in order to rivet in the top sheet in this way we found it necessary to reverse the angle iron, so that the angle iron would project up. Therefore, that would make a pocket on top, where water could accumulate. To obviate that difficulty, we bore a hole through the top sheet and through the side sheet into the coal space; bend a piece of flue and roll it in there so that it just makes a quarter turn on the flue, so that any water which accumulates there will run into the coal space. This is done on each leg.

MR. HENDERSON: I notice a paragraph in the report which says that the cost of air motors varies from $100 to $150. Of course, that does not state the size. I would like to say that we have a small air motor which we have had in use several months, which cost a trifle less than $25. It is of the oscillating type, 4½ inches in diameter, 6-inch stroke. It is used a great deal for boring out cylinders. One man can lift it up on to a truck and carry it around. Of course this cost does not include the patterns, but it includes the materials and castings, and the work.

MR. MCCONNELL: Mr. Chairman, reference is made here to motors purchased from manufacturers, not those made in shops.

MR. BARNETT: Such a type of vertical motor as I alluded to, with its reheater on three swiveling wheels, built so that any person can take it around any corner of the shop, can be built with very nice finish for $35.

I notice the report says that there was a saving of 100 per cent in one instance. I do not wish to criticise the statement too severely, but to draw the attention of the members of this convention generally to a weak point in our committees' reports, and sometimes in the technical press of today. Where any comparison is made with the present price, if we always bear in mind that all comparisons should be made on the maximum or old figure, there will be a uniformity of statement. Many of us just think of the present figure we are paying, and knowing that under the old arrangement we paid twice as much, the mental association there is that there is a saving of 100 per cent, and it has vitiated many of our statistics, in our proceedings in the past, where error of statement has not been quite as self-evident as it is in this particular report, and I only mention it now so that members will bear it in mind, and then we will have in future a stronger faith in some of our statements of percentage than I have in some of our past publications. [Applause.]

MR. MCCONNELL: I wish to say, for the information of Mr. Barnett, that the statement is absolutely correct from the information that we received in answer to our inquiries. We put that in the report as given by the parties replying.

MR. LEEDS: I think that we all appreciate the fact, or at least we should, that the quotations given here are for commercial articles. I do not think it is hardly a square thing to bring in here a report on what you might call makeshifts in a shop, and have it go before our management, and then when we make requests for certain tools, and they ask us how much it is going to cost, and we give a price, to have them say "Such and such parties have made a report that they accomplish all this for one-third or one-quarter as much." When such matters are brought forward, it should be with a full explanation. I think that nearly all our establishments some time or another have gotten up either steam or air motors for the shops, and like a good many locomotives that are built, nobody knows what they cost. [Laughter.]

MR. GEORGE GIBBS: It seems to me that this whole question, or the method of treatment, at least, which the committee has given this subject, narrows it down to one of labor-saving appliances rather than the relative merits of the three kinds of motive power, and possibly that was necessary because they had no data on any except one — that is, the air motors. I notice from the replies that the number of railroads reported as using electricity is only two, and they only have nine motors; and I confess, to our shame, that we did not reply to the circular, so that we are not included in those roads. I take exception to some of the statements of the committee as to the relative field for air and electric motors. Stating the matter broadly, I should say that air and steam, and hydraulic also, were suited to the field for pressure operations, to operations where blows were delivered, and electricity was pre-eminently suited to the operation of producing rotary motion. When I say the "field," I mean, of course, the field for small tools. I do not mean that the steam engine is not suitable for driving a shop. It is. I mean for driving isolated tools or conducting operations in places where portability is an object. Of course, in some cases a rotary motion produced by air may be an advantage, for I do not know of any electrical device that has been developed which is a practical one for drilling and tapping stay-bolt holes or where lightness is the prime essential. But there seems to be no reason why such tools should not be developed, and probably the reason why they have not been is that nobody connected with electrical manufacturing has been familiar with the needs of railway shops. I think that a very important department in a shop could be created if one man were to familiarize himself with the progress of electricity and be able to report on the relative advantages of that and air motors when the question of a portable tool came up. Mr. Barnett spoke of reheating air; I presume he means for the rotary motors. I believe, as I said before, if a shop were properly conducted, that there would be very few rotary air motors used, and, if you did use them, I believe that the question of reheating would be more difficult than Mr. Barnett imagines. The advisability of having a small fire or flame about different parts of a shop on a portable motor, I think, is very questionable. We have issued very stringent orders that no flame of any kind except for gas shall be allowed in any of our shops. That was due to our nearly burning down one of our large shops from the use of gasoline and oil in torches. As to saving 100 per cent, I would like to ask Mr. McConnell how he saves 100 per cent on the cost of any operation?

MR. McCONNELL: I wish to state for Mr. Gibbs' benefit that I cannot explain it, because I did not make the statement. The statement was made by one member to the committee in his reply to the inquiry, that he saved 100 per cent over the old way of handling that operation.

Mr. Morris: I agree with Mr. Gibbs as to having fires about the shop, and I think Mr. Barnett covered that point by saying that it was a pretty hard matter to establish a reheating plant for rotary motors, if I understood him rightly. But we established a little plant on our transfer table — a reciprocating machine, double cylinders 4 inches in diameter and 4½ inches stroke, and since we have been criticising the 100 per cent saving, I will say that the figures of saving are so close to 100 per cent in the handling of this transfer table that I think it may be well to give these figures to the Association and show what the real saving was. It cost us, prior to operating this table pneumatically, about $6 an engine to get it into the back shop. It costs now 40 cents. As to reheating the air, we have a small coil as described by Mr. Barnett, close to the motor, and in traversing 250 feet prior to reheating, the reduction of pressure in the reservoir was about twenty pounds. After reheating was introduced, the reduction was only twelve pounds, as shown by the gauge on this reservoir. We have a great many pneumatic tools and hoists, and as Mr. Mitchell said, we have to be very careful that they do not arrange hoists where they can be used when they should not be used. To promote economy we have to watch carefully to see that the hoists are not used where hand work will be cheaper.

Mr. Mitchell: It is very easy to reheat the air in a boiler shop where pneumatic riveting machinery is used, because you can put your coil feeding the air directly over the rivet-heating furnace and get the heat without using any gasoline or anything of that sort.

Mr. Mackenzie: I would ask Mr. Mitchell, in putting in this heating arrangement over his furnaces, if he did not destroy his hose very rapidly. Now we are using a coil. We have about 120 feet of ½-inch pipe. I think it is coiled up in about a circle of six inches. We have a sheet-iron casing around it, and we take that and set it near the machine, put a low charcoal fire in it, close it up, and that increases the flow of the air very perceptibly.

Some gentlemen here were talking some time ago about putting paper between the sheets and the angle iron in tender water in order to avoid leaking. I want to call attention to a little device that we have. We do not use paper. We use black asphaltum. We do no calking, but drive the rivets hot and the tank is a great deal better than if we had paper in it, and it saves not quite one hundred per cent, but very close to it.

Mr. Browne: In regard to reheating the air, we utilize the waste heat from our rivet heater, to warm the air. The reservoir is located overhead, and the pipe runs down and is coiled in this heat. We find there is an appreciable difference; just how much in figures I cannot say; but there is an appreciable difference. The air is used very close to this furnace. We do not claim any novelty in it, but we tried it for the purpose of securing economy, and we find that the air does get heated, and it is quite hot when it goes through the machine. We find one objection to it, which is that it makes the motor so hot that it requires an excessive amount of oil, and this oil, finding its way out at the exhaust, makes that portion of the shop rather unsightly. It is more difficult to keep the motor lubricated.

Mr. Henderson: I move that the discussion be closed.

Mr. Morris: A gentleman referred to the cost. I meant to state that the cost for one month for reheating the air for the transfer table was 70 cents.

The motion to close the discussion was put and carried.

The Chairman: Next is the report of the Committee on "Air Brake and Signal Instructions." Mr. Rhodes, the Chairman, not being present, I delegate the Secretary to read it and at the same time to explain the action that was taken on this in the Master Car Builders' Association, it being a report of a joint committee.

Mr. Cloud: It is not necessary to read any portion of this report, I think. This same report was presented to the Master Car Builders' Association and elicited some discussion and some suggestions of further modifications, and inasmuch as we have pretty nearly this same code of rules now extant and available, it was thought best by the Master Car Builders' Association to continue the subject for another year's consideration, so as to get it as nearly perfect as possible, and therefore it is a subject in that Association for consideration the coming year to be reported on again next year.

The report is as follows:

JOINT REPORT OF COMMITTEES ON REVISION OF AIR BRAKE AND SIGNAL INSTRUCTIONS.

To the Presidents and Members of the Master Car Builders' Association and American Railway Master Mechanics' Association:

The committees appointed by both Associations to revise the Air Brake and Signal Instructions have jointly agreed to recommend certain changes in these Instructions.

Whenever any new wording has been introduced it will be found printed in italics in the proposed revised instructions which follow. In some cases these are insertions and in some cases they take the place of other wording which is omitted. A new cut, Fig. 1*b*, has been introduced to show the modern engineer's valve, and the handle of this valve in both Fig. 1*a* and Fig. 1*b* is shown in the running position instead of in the release position as formerly.

Figs. 3, 4, 5 and 6 have been modified by showing grooves in the handle ends of the cock plugs parallel with the openings through the plugs, and the vertical dotted position of the handle in Fig. 6 has been omitted. Fig. 7 is shown in section instead of in outline, as formerly.

Some questions, principally referring to the straight air brake, have been omitted entirely.

The following is the proposed revised form:

See additions in italics.

AIR BRAKE AND SIGNAL INSTRUCTIONS.

GENERAL INSTRUCTIONS.

The following rules and instructions are issued for the government of all employes of this railroad whose duties bring them in contact with the maintenance or operation of the automatic air brake and train air signal. They must be obeyed in all respects, as employes will be held responsible for the observance of the same, as strictly as for the performance of any other duty.

Every employe whose duties are connected in any way with the operation of the air brake, will be examined from time to time as to his qualification for such duties, by the Inspector of Air Brakes or other person appointed by the proper authority, and a record will be kept of such examination.

A book of information has been issued, in convenient form, giving a complete explanation of all parts of the air brake and train air signal equipment, with directions for the care and operation of the same. Any employe of this railroad will be furnished with a copy of the same upon application at place designated by special notice, and every employe will be held responsible for a full knowledge of his duties in the operation or maintenance of the air brake or signal equipment. If the directions contained in that book are observed and the rules and instructions herewith are obeyed, no failure of the air brake *or train air signal*, at the time when it is needed, should occur. If such a failure does occur, it will be assumed that some employe has neglected his duty, and an investigation will be made to ascertain who is responsible for such failure.

INSTRUCTIONS TO ENGINEMEN.

GENERAL.—Engineers, when taking their locomotives, must see that the air-brake apparatus on locomotive and tender is in good working order; that the air pump and lubricator work properly; that the regulator prevents the train-pipe pressure exceeding a maximum of seventy (70) pounds; that an excess pressure of not less than twenty pounds *can be* maintained in the main reservoir when the handle of the engineer's brake valve is placed in position 2 (Running Position); that the engineer's brake valve works properly in all different positions of the handle; and that, when the brakes are fully applied, the driver brake pistons do not travel less than ⅓ nor more than ⅔ of their stroke, and the tender brake piston does not travel less than five nor more than eight inches.

Engineers must report to roundhouse foreman, at the end of the run, any defect in the air brake or signal apparatus.

MAKING UP TRAINS AND TESTING BRAKES.—The train pipe under the tender must always be blown out thoroughly before connecting to the train. Be sure to have 70 pounds train-pipe pressure on the engine, with the handle of the engineer's valve standing in position 2, before connecting to the train.

When the locomotive has been coupled to the train and it has been charged with an air pressure of 70 pounds, the engineer shall, at a signal from the inspector or trainman, apply the brakes *with full service application of not less than 20 pounds reduction*, and leave them so applied until the brakes on the entire train have been inspected and the signal is given to release. He shall then release the brakes, and shall not leave the station until it has been ascertained that all brakes are released and he has been informed by the inspector or *trainmen*. This test must be made after each change in the make-up of the train, and before starting down such grades as may be designated by special instructions. Where the train air signal is used, the signal to release the brakes, in testing, will be given from the rear car of the train, to show that the signal connections have been properly made.

SERVICE APPLICATION.—In applying the brakes to steady the train upon descending grades, or for reducing the speed for any purpose, be very careful not to make too great a reduction of pressure in the outset, as the speed of the train will be too quickly or too much checked, and it will be necessary to release the brakes and apply them again later, perhaps repeating the operation. APPLY THE BRAKES LIGHTLY AT A SUFFICIENT DISTANCE FROM THE STOPPING POINT, AND INCREASE THE BRAKING FORCE GRADUALLY, AS IS FOUND NECESSARY, SO AS TO MAKE THE STOP WITH ONE APPLICATION, OR AT MOST TWO APPLICATIONS OF THE BRAKES.

With freight trains first allow the slack to run up against the engine. Great care must then be taken to apply the brakes with 5 to 7 pounds reduction and not *make a second reduction until the effect of the first reduction is felt on entire train, in order to prevent shocks which otherwise may be serious.*

In making a service stop with a passenger train, ALWAYS RELEASE THE BRAKES A SHORT DISTANCE BEFORE COMING TO A DEAD STOP, except on heavy grades, to prevent shocks at the instant of stopping. Even on moderate grades it is best to do this, and then, after release, to apply the brakes lightly, to prevent the train starting, so that when ready to start the release will take place quickly. This does not apply to freight trains, upon which the brakes must not be released until the train has stopped.

THE ENGINEER'S BRAKE AND EQUALIZING VALVE AND DUPLEX AIR GAUGE.

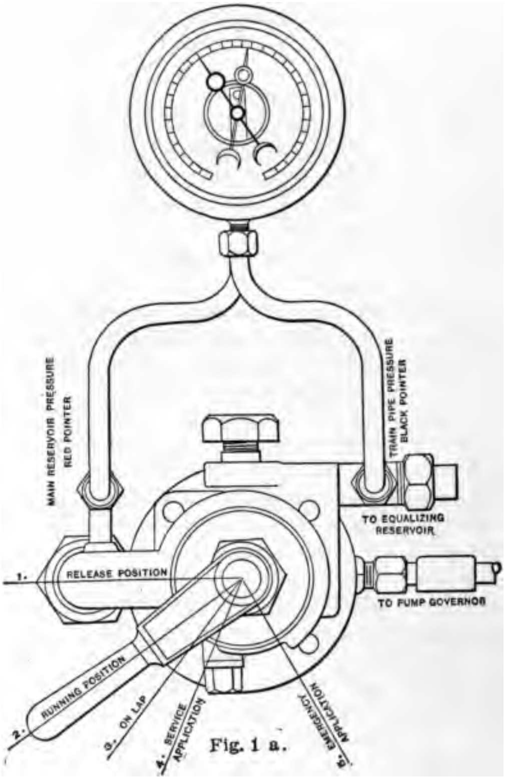


Fig. 1 a.

Emergency Applications.— The emergency application of the brakes must not be used, except in actual emergencies.

Brakes Applied from an Unknown Cause.— If it is found that the train is dragging at any time without a rapid fall of the black pointer, move the handle of the pressure on his engine and enabling him to assume charge of the train brakes should occasion require it.

An Extra Air Brake Hose and Coupling must always be carried on the engine for repairs in case of a burst hose. Upon engines having the air signal a signal hose and coupling must also be carried for the same purpose.

INSTRUCTIONS TO TRAINMEN.

Making Up Trains and Testing Brakes.—When the engine has been coupled to the train, or when two sections have been coupled together, the brake and signal couplings must be united, the cocks in the train pipes — both brake and signal —must all be open, except those at the rear end of the last car, which must be closed, and the hose hung up properly in the dummy coupling, *when cars are so equipped.*

THE PLAIN STRAIGHT-WAY COCK.

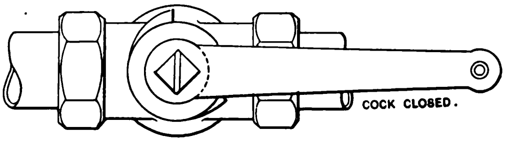


Fig. 4. Cock Closed.

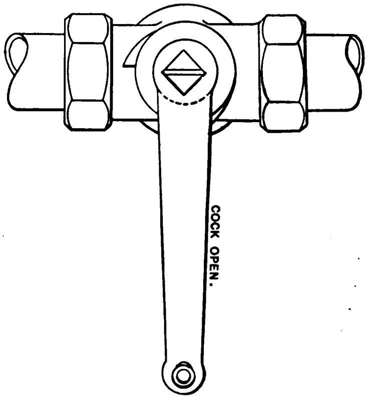


Fig. 5. Cock Open.

After the engineer has charged the train with air he must then be signaled to apply the brakes, *as provided for in the train rules.* When he has done so the brakes of each car must be examined to see if they are properly applied. When it is ascertained that each brake is applied the engineer must be signaled to release the brakes. When the train air signal is to be used the signal to the engineer to release the brakes

CUTTING OUT BRAKES.— THE DRIVER AND TENDER BRAKES MUST ALWAYS BE USED AUTOMATICALLY AT EVERY APPLICATION OF THE TRAIN BRAKES, unless defective — except upon such grades as shall be designated by special instructions.

When necessary to cut out either driver or tender brake, on account of defects, it shall be done by turning the handle of the four-way cock in the triple valve down to a position midway between a horizontal and a vertical position, *first releasing the brake* and leaving the bleed cock open. *With the special driver brake triple valve, close the cut-out cock in the branch pipe.*

THE ANGLE COCK.

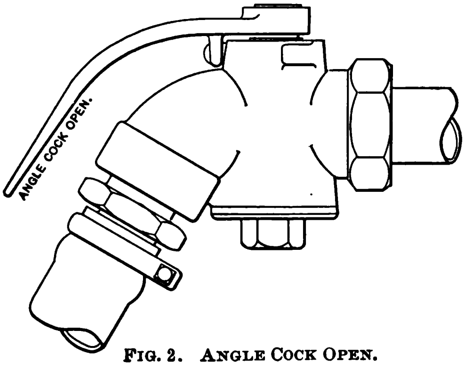


FIG. 2. ANGLE COCK OPEN.

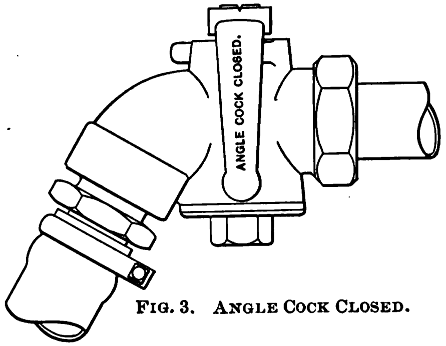


FIG. 3. ANGLE COCK CLOSED.

DOUBLE HEADERS.— When two or more engines are coupled in the same train the brakes must be connected through to and operated from the head engine. For this purpose a cock is placed in the train pipe just below the engineer's valve. The engineer of each engine, except the head one, must close this cock and place the handle of the engineer's valve in position 2. He will start his air pump and let it run, as though he were going to use the brake, for the purpose of maintaining air pressure on his engine and enabling him to assume charge of the train brakes should occasion require it.

An Extra Air Brake Hose and Coupling must always be carried on the engine for repairs in case of a burst hose. Upon engines having the air signal a signal hose and coupling must also be carried for the same purpose.

INSTRUCTIONS TO TRAINMEN.

Making Up Trains and Testing Brakes.—When the engine has been coupled to the train, or when two sections have been coupled together, the brake and signal couplings must be united, the cocks in the train pipes — both brake and signal —must all be open, except those at the rear end of the last car, which must be closed, and the hose hung up properly in the dummy coupling, *when cars are so equipped.*

THE PLAIN STRAIGHT-WAY COCK.

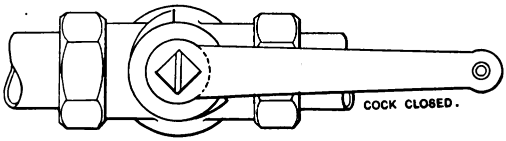


Fig. 4. Cock Closed.

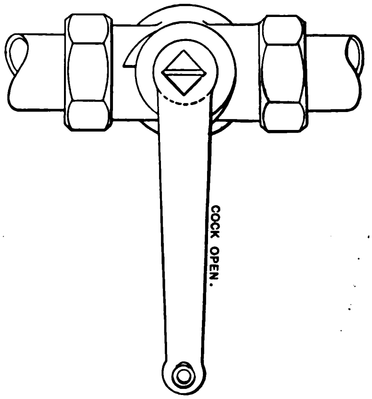


Fig. 5. Cock Open.

After the engineer has charged the train with air he must then be signaled to apply the brakes, *as provided for in the train rules.* When he has done so the brakes of each car must be examined to see if they are properly applied. When it is ascertained that each brake is applied the engineer must be signaled to release the brakes. When the train air signal is to be used the signal to the engineer to release the brakes must be given by means of the air signal from the rear car of the train. The brakes of each car must then be examined to see that each is released.

If any defect is discovered it must be remedied and the brakes tested again — the operation being repeated until it is ascertained that everything is right. The conductor and engineer must then be notified that the brakes are all right. This examination must be made every time any change is made in the make-up of the train and before starting down such grades as may be designated by special instructions. At points where there are no inspectors trainmen must carry out these instructions. No passenger train must be started out from an inspection point with the brakes upon any car cut out or in a defective condition without special orders from the proper officers. The air brakes must not be alone relied upon to control any freight train with a smaller proportion of cars with the air brake in service than the division time card specifies. When hand brakes are also used they must be applied upon those cars next behind the air-braked cars.

THE PLAIN AUTOMATIC TRIPLE VALVE.

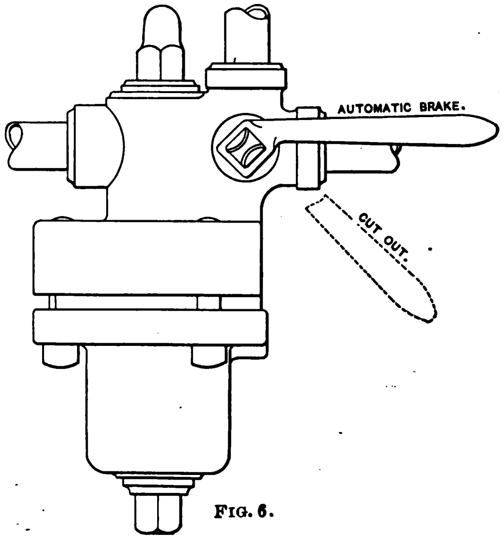


FIG. 6.

DETACHING ENGINE OR CARS.— First close the cocks in the train pipes at the point of separation, and then part the couplings, invariably by hand. If the brakes have been applied, do not close the cocks until the engineer has released the brakes upon the whole train.

COUPLINGS FROZEN.— If the couplings are found to be frozen together or covered with an accumulation of ice, the ice must first be removed and then the couplings thawed out by a torch to prevent injury to the gaskets.

Brakes Sticking.— If brakes are found sticking, the engineer must be signaled "*brakes sticking*," *as provided for in the train rules. If the engineer cannot release the brakes, or if the brakes* are applied to detached cars, the release may be effected by opening the *bleed* cock in the auxiliary reservoir until the air begins to release through the triple valve, when the reservoir cock must immediately be closed.

Train Breaking into Two or More Parts.— First close the cock in the train pipe at the rear of the first section and signal the engineer to release the brakes, Having coupled to the second section, observe the rule for making up trains — first being sure that the cock in the train pipe at the rear of the second section has been closed, if the train has broken into more than two sections. When the engineer has released the brakes on the second section the same method must be employed with reference to the third section, and so on. When the train has been once more entirely united the brakes must be inspected on each car to see that each is released before proceeding.

Cutting Out the Brake on a Car.— If, through any defect of the brake apparatus while on the road, it becomes necessary to cut out the brake upon any car, it may be done by closing the cock in the cross-over pipe near the center of the car where the quick-acting brake is used, or by turning the handle of the cock in the triple valve to a position midway between a horizontal and vertical where the plain automatic brake is used, *first releasing the brake*. When the brake has been thus cut out, the cock in the auxiliary reservoir must be opened and left open upon passenger cars, or held open until all the air has escaped from the reservoir upon freight cars. The brake must never be cut out upon any car unless the apparatus is defective, and when it is necessary to cut out a brake the conductor must notify the engineer and also send in a report stating the reasons for so doing.

THE PRESSURE RETAINING VALVE.

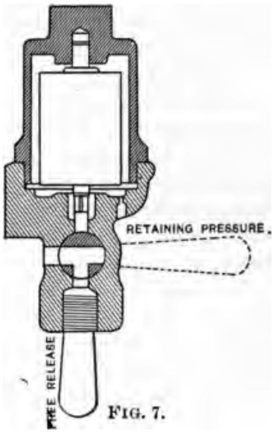


Fig. 7.

CONDUCTOR'S VALVE.— Should it become necessary to apply the brakes from the train, it may be done by opening the conductor's valve, placed in each passenger equipment car. THE VALVE MUST BE HELD OPEN UNTIL THE TRAIN COMES TO A FULL STOP, AND THEN MUST BE CLOSED AGAIN.

This method of stopping the train must not be used except in case of emergency.

BURST HOSE.— In the event of the bursting of a brake hose, it must be replaced and the brakes tested before proceeding, provided the train be in a safe place. If it is not, the train pipe cock immediately in front of the burst hose must be closed, and the engineer signaled to release. All the brakes to the rear of the burst hose must then be released by hand, and the train must then proceed to a safe place where the burst hose must be replaced and the brakes again connected and tested as in making up a train.

BRAKES NOT IN USE.— When the air brakes are not in use, either upon the road or in switching, the hose must be kept coupled between the cars or hung up properly to the dummy couplings, *when cars are so equipped.*

PRESSURE-RETAINING VALVE.— When this valve is to be used, the trainmen must, at the top of the grade, test the brakes upon the whole train, and must then pass over the train and turn the handles of the pressure-retaining valves horizontally (position 2) upon all or a part of the cars, as may be directed. At the foot of the grade, the handles must all be turned downward again (position 1). Special instructions will be issued as to the grades upon which these valves are to be used.

TRAIN AIR SIGNAL.— In making up trains, all couplings and car discharge valves on the cars must be examined to see if they are tight. Should the car discharge valve upon any car be found to be defective while on the road, it may be cut out of use upon that car by closing the cock in the branch pipe leading to the valve. The conductor must always be immediately notified when the signal has been cut out upon any car, and he must report the same for repairs.

In using the signal, pull directly down upon the cord during one full second, for each intended blast of the signal whistle, and allow two seconds to elapse between the pulls.

REPORTING DEFECTS TO INSPECTORS.— Any defect in either the air brake or air signal apparatus discovered upon the road must be reported to the inspector at the end of the run; or, if the defect be a serious one in passenger service, it must be reported to the nearest inspector, and it must be remedied before the car is again placed in service.

INSTRUCTIONS TO ENGINE HOUSE FOREMEN.

GENERAL.— It is the duty of engine-house foremen to see that the air brake and signal equipment is properly inspected upon each engine after each run. It must be ascertained that all pipe joints, connections and all other parts of the apparatus are air tight, and that the apparatus is in good working order.

AIR PUMP.— The air pump must be tested under pressure, and if found to be working imperfectly in any respect, it must be put into thoroughly serviceable condition.

PUMP GOVERNOR.— The pump governor should cut off the steam supply to the pump, when the train pipe pressure has reached seventy (70) pounds, *with D 8 brake valve, and at 90 pounds main reservoir pressure with E 6 or F 6 valve.* If it does not, it must be regulated to do so.

ENGINEER'S BRAKE VALVE.— This valve must be kept clean and in perfect order. With the handle in position 2, the main reservoir pressure must not be less than twenty pounds greater than train pipe pressure. The valve must be tested with the handle in positions 4 and 3, to note that the equalizing piston responds promptly, and that there are no leaks from port to port under the rotary disk valve.

ADJUSTMENT OF BRAKES.— The driver brakes must be so adjusted that the pistons travel not less than one-third nor more than two-thirds of their stroke. When the cam brake is used care must be taken to adjust both cams alike, so that the point of contact of the cams shall be in line with the piston rod. The tender brake must be adjusted by means of the dead truck levers, so that the piston travels not less than five nor more than six inches when the air brake is applied and the hand brake is released. This adjustment must be made whenever the piston travel is found to exceed eight inches.

BRAKE CYLINDERS AND TRIPLE VALVES.— These must be examined and cleaned once every six months, and the cylinders oiled once in three months. If the driver brake cylinders are in a position to be affected by the heat of the boiler, they must be oiled more frequently. A record must be kept of the dates of last cleaning and oiling for each engine.

DRAINING.— The main reservoir, and also the drain cup in the train pipe under the tender must be drained of any accumulation after each trip. The auxiliary reservoirs and triple valves must also be drained frequently, and daily in cold weather, and the train pipe under the tender blown out.

AIR SIGNAL.— The train air signal apparatus must be examined and tested by opening and closing the cock in the signal pipe, at the rear of the tender, to see that the whistle responds properly. A pressure gauge must be applied to the air signal pipe, once each month, to ascertain that the reducing valve maintains the proper pressure of *forty* pounds per square inch in the train signal pipe.

INSTRUCTIONS TO INSPECTORS.

GENERAL.— It is the duty of all inspectors to see that the couplings, the pipe joints, the conductor's valves, the air signal valves, and all other parts of the brake and signal apparatus are in good order and free from leaks. For this purpose they must be tested under *the* full air pressure *as used in service.* No passenger train must be allowed to leave a terminal station with the brake upon any car cut out, or in a defective condition, without special orders from the proper officer.

If a defect is discovered in the brake apparatus of a freight car, which cannot be held long enough to give time to correct such defect, the brake must be cut out and the car properly carded, to call the attention of the next inspector to the repairs required.

The division time card rules specify the smallest proportion of freight cars, with the air brakes in good condition, which may be used in operating the train as an air brake train.

Making Up Trains and Testing Brakes.— In making up trains, the couplings must be united and the cocks at the ends of the cars all opened, except at the rear end of the last car, where the cocks must be closed and the couplings properly hung up to the dummy couplings. After the train is charged, the engineer must be signaled to apply the brakes. When the brakes have been applied, they must be examined upon each car to see that they are applied *with proper piston travel.* This having been ascertained, the inspector must signal the engineer to release the brakes, using the train air signal from the rear car, upon passenger trains. He must then again examine the brakes upon each car to note that each is released. If any defect is discovered, it must be corrected and the testing of the brakes repeated, until they are found to work properly. The inspector must then inform both the engineer and conductor *of the number of cars with brakes in good order.*

This examination must be repeated if any change is made in the make-up of the train before starting.

Cleaning Cylinders and Triple Valves.— The brake cylinders and triple valves must be kept clean and free from gum. They must be *cleaned and oiled* as often as once in six months, upon passenger cars, and once in twelve months upon freight cars. *The* dates of last cleaning and oiling *must be* marked with *white paint* upon the cylinder in the places left for such dates opposite the words, which will be stenciled with white paint, in one-inch letters, upon the cylinder *or reservoir* as follows:

Cylinder cleaned and oiled ....

Triple cleaned and oiled ....

The triple valves and auxiliary reservoirs must be frequently drained, especially in cold weather, by removing the plug in the bottom of the triple valve and opening the small cock in the reservoir.

Adjustment of Brakes.—The slack of the brake shoes must be taken up by means of the dead truck levers.

In taking up such slack, it must be first ascertained that the hand brakes are off, and the slack is all taken out of the upper connections, so that the live truck-levers do not go back within 1½ inches of the truck timber or other stop, when the piston of the brake cylinder is fully back at the release position. When, under a full application, the brake piston travel is found to exceed eight inches upon a passenger car or nine inches upon a freight car, the brake shoe slack must be taken up and the adjustment so made that the piston shall travel not less than five inches nor more than six inches.

Braking Power.—Where the cylinder lever has more than one hole at the outer end the different holes are for use upon cars of different weights.

It must be carefully ascertained that the rods are connected to the proper holes, so that the correct braking power shall be exerted upon each car.

Repair Parts.—Inspectors must keep constantly on hand for repairs a supply of all parts of the brake and signal equipment that are liable to get out of order.

Hanging up Hose.—Inspectors must see that, when cars are being switched or standing in the yard, the hose is coupled between the cars or properly secured in the dummy coupling, *when cars are so equipped.*

Responsibility of Inspectors.—Inspectors will be held strictly responsible for the good condition of all the brake and signal apparatus upon cars placed in trains at their stations; they will also make any examination of brake apparatus or repairs to the same, which they may be called upon to do by trainmen.

GENERAL QUESTIONS

REGARDING THE USE OF THE

AIR BRAKE AND TRAIN SIGNAL.

GENERAL QUESTIONS.

(All parties who have to do with the use, adjustment, care or repairs of air brakes should be thoroughly examined on these questions, in addition to the special questions for each class of men following them.)

1. Question. What is an air brake?

Answer. It is a brake applied by compressed air.

2. Q. How is the air compressed?

A. By an air pump on the locomotive.

3. Q. How does the compressed air apply the brakes?

A. It is admitted into a brake cylinder on each car, and it pushes out a piston in that cylinder which pulls the brake on.

4. Q. How does the piston get back when the brakes are released?

A. There is a spring around the piston rod which is compressed when the brakes are applied, and when the air is allowed to escape to release the brakes, this spring reacts and pushes the piston in again.

5. Q. Where is the compressed air kept ready for use in the automatic air brake?

A. In the main reservoir on the locomotive, in the smaller or auxiliary reservoir on each car, and in the train pipe.

6. Q. Where does the compressed air come from directly, that enters the brake cylinder when the automatic brake is applied?

A. It comes from the auxiliary reservoir on each car *in service application, and from the auxiliary reservoir and train pipe in emergency application.*

7. Q. How does it get into the auxiliary reservoir?

A. It is furnished from the main reservoir on the locomotive through the train pipe *and triple valve* when the brakes are released.

8. Q. How is the automatic brake applied and released?

A. *The automatic brake is applied by reducing the air pressure in the train pipe below that in the auxiliary reservoir, and is released by raising the train pipe pressure above that remaining in the auxiliary reservoir.*

9. Q. Why does the compressed air not enter directly into the brake cylinder from the train pipe?

A. Because the triple valve used with the automatic brake prevents the air from entering directly from the train pipe to the brake cylinder when the pressure in the train pipe is maintained or increased.

10. Q. What other uses has the triple valve?

A. It causes the brake cylinder to be opened to the atmosphere under each car, and releases the brakes when the pressure in the train pipe is *made greater than that in the auxiliary reservoir*, and it opens communication from the train pipe to the auxiliary reservoir by the same movement; when the pressure in the train pipe is reduced, it closes the openings from the train pipe to the auxiliary reservoir and from the brake cylinder to the atmosphere, and then opens the passage between the auxiliary reservoir and the brake cylinder by the same movement, so as to admit the air and apply the brakes.

11. Q. How many forms of triple valves are there in use, and what are they called?

A. Two: the plain triple and the quick-acting triple.

12. Q. How can you tell the plain triple from the quick-acting triple?

A. The plain triple has a four-way cock in it, with a handle for operating the cock; the quick-acting triple has no such cock in it, but there is a plug cock in the cross-over pipe leading from the train pipe to the triple, when the quick-acting triple is used.

13. Q. What are these cocks for in both cases?

A. They are to be used to cut out brakes on one car, without interfering with other brakes on the train, if the brake on that car has become disabled.

14. Q. How does the cock handle stand in the plain triple valve when the pipe is open for automatic action?

A. It stands in a horizontal position.

15. Q. In what position does the same handle stand when the brakes are cut out by closing the cock?

A. It stands at an inclined position midway between horizontal and vertical.

16. Q. How does the handle of the plug cock in the cross-over pipe, used with the quick-acting triple, stand for automatic action?

A. It stands with the handle crosswise with the pipe, and the cock is then open.

17. Q. How does it stand when the cock is closed and the brake cut out of action?

A. It stands with handle lengthwise of cross-over pipe.

18. Q. How is the train pipe coupled up between the cars?

A. By means of a rubber hose on each end of the train pipe, fitted with a coupling at the loose end.

19. Q. How is the train pipe closed at the rear end of the train?

A. By closing the cock in the train pipe at the rear end of the last car.

20. Q. How many such train pipe cocks are there to a car, on the air brake train pipe and on the air signal train pipe, and why?

A. Two for each pipe on each car, because either end of any car may sometimes be at the rear end of the train.

21. Q. How many kinds of train pipe cocks are there in use at the ends of the cars?

A. Two.

22. Q. Describe each and give the position of the handles for open and closed in each case?

A. The older form of train pipe cock is a straight plug cock in the train pipe, not far from the hose connection; the handle stands crosswise with the pipe when it is open, and lengthwise with the pipe when closed; it is now found principally on the air signal pipe. The other form of train pipe cock now used on the air brake pipe is an angle cock placed at the end of the train pipe and close to the hose. The handle of the angle cock stands lengthwise with the pipe when open, and crosswise with the pipe when closed.

23. Q. What uses have these train pipe cocks besides to close the pipe at the rear end of the train?

A. They are to be used to close the train pipe at both sides of any hose coupling which is to be parted, as when the train is cut in two.

24. Q. Why is it necessary to close the train pipe on both sides of the hose coupling before it is parted?

A. To prevent the escape of air from the train pipe which would apply the brakes.

25. Q. How must the hose coupling be parted when it is necessary to do so, and why?

A. The air brake must first be released on the train *from the engine*, then the adjacent train pipe cocks must both be closed and the coupling must be parted by hand, to prevent the possibility of injury to the rubber gasket in the coupling.

26. Q. Why must the brakes be fully released before uncoupling the hose between the cars?

A. Because if the brakes are applied upon a detached car, they cannot be released without bleeding the auxiliary reservoir, and thus wasting air.

27. Q. In coupling or uncoupling the hose between cars, what must be done if there is ice on the couplings?

A. The ice must first be removed and the couplings thawed out, so as to prevent injury to the rubber gaskets in uncoupling, and to insure tight joints in coupling the hose.

28. Q. What must be done with a hose coupling which is not coupled up, such as the rear hose of a train, or any hose on a car which is standing or running, but not in use?

A. It must be placed in the dummy coupling *if* provided for in such manner that the flat pad on the dummy will close the opening in the coupling.

29. Q. What pressure should be carried in the train pipe and auxiliary reservoir?

A. Seventy pounds pressure to the square inch.

30. Q. Why should this pressure be 70 pounds?

A. Because this pressure is necessary, to get the full braking force which each car is capable of using, and, if it be exceeded, there will be danger of sliding the wheels.

31. Q. How much pressure can be obtained in the brake cylinder by the *service* application of the brakes with 70 pounds in the auxiliary reservoir.

A. About 50 pounds pressure to the square inch, with an eight-inch piston travel.

32. Q. Why can only 50 pounds pressure be obtained under these circumstances?

A. Because the air, at 70 pounds pressure in the auxiliary reservoir, expands into *an additional* space when the auxiliary reservoir is opened to the brake cylinder, and, when the pressure has become equalized, it is thus reduced to 50 pounds.

33. Q. How much must the train pipe pressure be reduced, in order to get 50 pounds pressure in the brake cylinder, in ordinary service?

A. Twenty pounds; or from 70 pounds down to 50 pounds in the train pipe also.

34. Q. Can the brakes be applied so as to get only a portion of this 50 pounds pressure in the brake cylinder, and how?

A. They can be so applied by reducing the train pipe pressure less than 20 pounds.

35. Q. If the train pipe pressure be reduced 10 pounds what will the pressure be in the brake cylinder?

A. About 25 pounds.

36. Q. How is this graduated action obtained?

A. By means of the graduating valve in the triple valve.

37. Q. Is it important to keep all the air brake apparatus tight and free from leaks?

A. Yes.

38. Q. Why is this important?

A. In order to get full service from the air brakes, and to prevent the waste of air, and also to prevent the brakes applying automatically by reason of leak in the train pipe.

39. Q. Is it important to know that the train pipe is open throughout the train and closed at the rear end before starting out?

A. Yes; this is very important.

40. Q. Why is this very important?

A. Because if any cock in the train pipe were closed, all the brakes back of the cock which is closed would be prevented from working.

41. Q. How can you know that the train pipe cocks are all open when the train is made up?

A. By testing the brakes; that is, by applying and releasing them, and observing whether they all operate.

42. Q. Do you understand that no excuse will be acceptable for starting out the train without first testing the air brakes?

A. Yes.

43. Q. Why is this rule absolute?

A. Because the safety of passengers and of property depends upon the brakes being properly coupled up and in an operating condition before the train is started.

44. Q. At what other times should the brakes be tested, and how?

A. After each change in the make-up of the train and before starting the train down certain designated grades, and the test should be made with a full *service* application of the brakes.

45. Q. How much air pressure should be carried in the air signal train pipe?

A. *Forty* pounds pressure.

46. Q. Is it important that this train pipe and its connections be also kept tight?

A. Yes.

47. Q. After taking up the slack of the brake shoes, how far should the brake piston travel in the cylinders on cars and tenders with a full application of the brake?

A. Not less than 5 inches nor more than 6 inches.

48. Q. What would happen if the piston traveled less than 5 inches when brakes are fully applied?

A. A partial application of the brakes might not close the leakage groove in the brake cylinder provided for the escape of small amounts of air.

49. Q. Why should the piston travel not be permitted to exceed eight inches on passenger cars and tenders, or nine inches on freight cars?

A. Because, if it travels *farther* than this when sent out, a little wear of the brake shoes will cause the piston to travel far enough to rest against the back cylinder head when the brakes are applied, and this cylinder head would then take the pressure instead of its being brought upon the brake shoes.

50. Q. How far should the driver brake piston travel with a full application of the brakes, and why?

A. Not less than one-third of the full stroke of the piston nor more than two-thirds of its full stroke, for reason similar to those given for cars and tenders.

51. Q. If the brakes stick upon any car so that the engineman cannot release them at any time, how *should they be released?*

A. By opening the release cock in the auxiliary reservoir and holding it open until air begins to escape from the triple valve and then closing it again.

52. Q. What is the pressure-retaining valve, and what is its use?

A. The pressure-retaining valve is a small valve placed at the end of a pipe from the triple valve, through which the exhaust takes place from the brake cylinder. It is used to retard the brake release on heavy grades, and hold the brakes partially applied, so as to allow more time for the engineman to recharge the auxiliary reservoir.

53. Q. What precautions are necessary on every train in regard to house couplings?

A. Every train must carry at least two extra hose and couplings complete, for use in replacing any hose couplings which may fail or become disabled. These extra hose and couplings to be carried on such part of the train as is required by the rules and regulations.

SPECIAL FOR ENGINEMEN.

54. Q. How should the air pump be started?

A. It should be started slowly, so as to allow the condensation to escape from the steam cylinder and prevent pounding, which is more likely to occur when the air pressure is low.

55. Q. Why should the piston rod on the air pump be kept thoroughly packed?

A. To prevent *the waste of air and steam.*

56. Q. How should the steam cylinder of the air pump be oiled, and what kind of oil should be used?

A. It should be oiled as little as necessary through a sight feed lubricator, and cylinder oil should be used.

57. Q How should the air cylinder of the air pump be oiled; what kind of oil, and why?

A. It should be oiled very little by once filling the oil-cup with West Virginia well oil daily. Cylinder oil, lard oil and other animal or vegetable oils must not be used, as their use causes the engineer's brake valve and the triple valves to gum up. The oil must never be introduced through the air inlet ports, as this practice would cause the pump valves to gum up.

58. Q. What regulates the train pipe pressure?

A. The pump governor, *with D 8 valve, and the feed valve attachment with the E 6 or F 6 valve.*

59. Q. *Why should the train pipe pressure not exceed 70 pounds?*

A. Because 70 pounds train pipe pressure produces the strongest safe pressure of the brake shoes upon the wheels. A higher train pipe pressure is liable to cause the wheels to slide.

60. Q. Why is the equalizing engineer's valve better than the older forms?

A. Because it enables the engineer to apply the brakes more uniformly throughout the train, and with less shock to the train, especially when the quick-acting triple valves are used. It also prevents the brakes from being kicked off on the forward end of the train when the engineer closes the valve after applying the brakes.

61. Q. Why does the equalizing engineer's valve produce these results in ordinary service stops?

A. Because the engineer does not, in such cases, open the train pipe to the atmosphere direct, but he only reduces the air pressure above the piston in the engineer's valve, which causes that piston to open the train pipe to the atmosphere, and to close the opening gradually when the train pipe pressure has been correspondingly reduced.

62. Q. What does the excess pressure valve in the *D 8 brake* valve accomplish, and do you regard it important to have it working properly?

A. It maintains an excess pressure in the main reservoir above the pressure in the train pipe, and it is important that it be kept clean and in working order so as to have this excess pressure to insure release, and for use in recharging the train quickly after the brakes are released.

63. *Q. What does the feed valve attachment of the E 6 or F 6 engineer's valve accomplish?*

A. When properly adjusted it restricts the train pipe pressure to a maximum of 70 pounds with the engineer's valve in running position. When this valve is used, the pump governor is attached to main reservoir pressure and may be set to carry whatever pressure is desired therein.

64. Q. How often should the brake valve be thoroughly cleaned and oiled?

A. At least once every two months.

65. Q. If the rotary disk valve in the engineer's valve is unseated by dirt or by wear, what may be the result, and what should be done?

A. It may be impossible to get the excess pressure; when the brakes have been applied they may keep applying harder until full on, or when they have been applied they may go off. The rotary disk valve should be thoroughly cleaned, and if worn it should be faced and ground to a seat.

66. Q. If the piston in the engineer's valve becomes gummed up or corroded from neglect to clean it, what will be the result?

A. It will be necessary to make a large reduction of pressure through the preliminary exhaust port before the brakes will apply at all, and then the brakes will go on too hard, and will have to be released.

67. Q. When the engine is standing alone and the pump is running, why must the *D 8* engineer's valve not be left standing in the lap position (No. 3)?

A. Because the main reservoir pressure may become so high that, when the handle of the engineer's valve is again placed in the release position, it will cause the train pipe and tender auxiliary reservoir to be charged with too high pressure, which might injure the adjustment of the pump governor as well as cause the tender wheels to be slid with the first application of the brakes.

68. Q. How and why should the train pipe under the tender always be blown out thoroughly before connecting up to the train?

A. By opening the angle cock at the rear end of the tender and allowing the air from the main reservoir to blow through. This blows out the oil, water, scale, etc., which may accumulate in the pipe, and which would be blown back into the train pipe and triple valves if not removed before coupling to the train.

69. Q. When the engine is coupled to the train, why is it necessary to have the full train pipe pressure and the excess pressure on the main reservoir?

A. So that the brakes will all be released and the train quickly charged when the engineer's valve is placed in the release position.

70. Q. Why should the driver brakes always be operated automatically with the train brake?

A. Because it adds greatly to the braking force of the train, and the brakes can be applied alike to all the wheels for ordinary stops, and in an emergency the greatest possible braking force is at once obtained by one movement of the handle.

71. Q. In making a service application of the brakes, how much reduction of the train pipe pressure from 70 pounds does it require to get the brakes full on?

A. About *25* pounds reduction.

72. Q. What should the first reduction be in such an application, and why?

A. From *five to seven* pounds, so as to insure moving the pistons in the brake cylinders past the leakage groove, yet not apply the brakes too hard, until the slack in drawbars and drawsprings is first taken up.

73. Q. What is the result of making a greater reduction of pressure than *25* pounds?

A. A waste of air in the train pipe, without getting any more braking force, and therefore requiring more air to release the brakes.

74. Q. How many applications of the brakes are necessary in making a stop?

A. Generally only one; by applying them lightly at first with six or eight pounds reduction of air in the train pipe, and afterward gradually increasing the force of the application. Two applications are as many as should ever be required.

75. Q. Why is it dangerous to apply and release the brakes repeatedly in making stops?

A. Because every time the brakes are released the air in the brake cylinders is thrown away, and if it is necessary to apply them again before sufficient time has elapsed to recharge the auxiliary reservoirs the application of the brakes will be weak, and after a few such applications the brakes are almost useless on account of the air having been exhausted from the auxiliary reservoirs.

76. Q. In releasing and recharging the train, how long should the handle of the engineer's valve be left in the release position?

A. Until the train pipe pressure has risen nearly to 70 pounds again.

77. Q. In making service stops with passenger trains, why should you release the brakes a little before coming to a full stop?

A. So as to prevent stopping with a lurch; it also requires less time for the full release of the brakes after stopping.

78. Q. In making stops with freight trains, why should the brakes not be released until after the train has come to a full stop?

A. Because long freight trains are apt to be parted by releasing the brakes at low speed.

79. Q. In making service stops, why must the handle of the engineer's valve not be moved past the position for service applications?

A. So as to prevent unnecessary jerks to the train, and the emergency action of the triple valve when not necessary.

80. Q. If you find the train dragging from the failure of the brakes to release, how can you release them?

A. By placing the handle of engineer's valve in the *lap* position until *an* excess *of* pressure is attained, and then throwing it into the *full* release position.

81. Q. When the brakes go on suddenly when not operated by the engineer's valve, and the gauge pointer falls back, what is the cause, and what should you do?

A. Either a hose has burst, or a conductor's valve has been opened, or the train has parted. In any event, the handle of the engineer's valve must be immediately placed in the lap position to prevent the escape of air from the reservoir.

82. Q. Are the brakes liable to stick on after an emergency application, and why?

A. The brakes are harder to release after a severe application, because they are on with full force, and it requires higher pressure than usual in the train pipe to release them again. In this case it is necessary always to have in reserve the excess pressure on the main reservoir to aid in releasing the brakes. With the quick-acting triple valve this is especially necessary, because air from the train pipe as well as from the auxiliary reservoir is forced into the brake cylinder when a quick application of the brake is made, thus increasing the pressure in the brake cylinder without the usual reduction of pressure in the auxiliary reservoir, and requiring a high pressure in the train pipe afterward to cause the brakes to be released.

83. Q. In using the brakes to steady the train while descending grades, why should the air pump throttle be kept well open?

A. So that the pump may quickly accumulate a full pressure in the main reservoir for use in recharging the train when the brakes have been released again.

84. Q. In descending a grade how can you best keep the train under control?

A. First, by commencing the application of the brakes early, so as to prevent too high a speed being reached. Second, by applying the brakes lightly at first, then increasing the brake pressure as needed, and by slowing the train down just before it is necessary to release the brakes for recharging, so as to give time enough to refill the auxiliary reservoirs before much speed is again attained.

85. Q. If the train is being drawn by two or more engines, upon which engine should the brakes be controlled, and what must the enginemen of the other engines do?

A. The brakes must be controlled by the leading engine, and the enginemen of the following engines must close the cock in the train pipe just below the engineer's valves. The latter must always keep his pump running and in order, and main reservoir charged, with the engineer's valve in the running position, so that he may quickly operate the brakes if called upon to do so.

86. Q. If the air signal whistle only gives a weak blast, what is the probable cause?

A. Either the reducing valve is out of order so that the pressure is less than *40* pounds or the whistle itself is filled with dirt or not properly adjusted *or the port under the end of signal valve is partially closed by gum or dirt.*

87. Q. If the reducing valve for the air signal is allowed to become clogged up with dirt, what will the result probably be?

A. The signal pipe might get the full main reservoir pressure, and the whistle will blow when the brakes are released.

88. Q. If you discover any defect in *the* air brake or signal apparatus while on the road, what must *be done ?*

A. If it is something that cannot be readily remedied at once, it must be reported to the engine-house foreman as soon as the run is completed.

89. Q. What is the result if water be allowed to collect in the main reservoir of the brake apparatus?

A. The room taken up by the water reduces the capacity for holding air, and the brakes are more liable to stick. In cold weather also the water may freeze and prevent the brakes from working properly.

SPECIAL FOR ENGINE REPAIRMEN.

90. Q. How often must the air brake and signal apparatus on locomotives be examined?

A. After each trip.

91. Q. Under what pressure must it be examined?

A. Under full pressure, i. e., 70 pounds on the air brake train pipe, 20 pounds excess in the main reservoir, and *40* pounds pressure upon the air signal train pipe.

92. Q. How will you be sure that proper pressures are upon the two train pipes?

A. By regulating, and, if necessary, cleaning the pump governor so that it will shut off steam from the pump when 70 pounds train pipe pressure is reached, and by examining, and, if necessary, cleaning the pressure reducing valve for the signal train pipe, so that it maintains *40* pounds pressure in the train pipe.

93. Q. If you do not obtain 20 pounds excess pressure in the main reservoir when the handle of the *D 8* engineer's valve is in the running position, what is the cause?

A. Either the excess pressure valve needs cleaning, or the rotary disk valve in the engineer's valve is unseated and allows air to leak from one port to another.

94. Q. Why must the air-pump piston rod be kept well packed?

A. To prevent *leakage of steam and air.*

95. Q. How often must the main reservoir and the drain cup under the tender be drained?

A. After each trip.

96. Q. How often must the triple valves and the cylinders of the driver and tender brakes be cleaned and oiled?

A. They must be thoroughly cleaned and oiled with a small amount of mineral oil once every six months, and the cylinders must be oiled every three months. If the driving brake cylinders are so located that they become hot from the boiler, they may require oiling more frequently.

97. Q. If there are any leaks in the pipe joints or anywhere in the apparatus, what must you do?

A. Repair them before the engine goes out.

98. Q. How is the brake shoe slack of the cam driver brake taken up, and what precautions are necessary?

A. By means of the cam screws, and it is necessary to lengthen both alike, so that when the brake is applied the point of contact of the cams will be in a line with the piston rod.

99. Q. How is the brake shoe slack of driver brakes on a locomotive with more than two pairs of driving wheels taken up?

A. By means of a turn-buckle or screw in the connecting rods.

100. Q. How is the slack of the tender brake shoes taken up?

A. By means of the dead truck levers; if they will not take it up enough, it must be taken up in the underneath connection, and then adjusted by the dead lever.

101. Q. How far should the driver brake piston travel in applying the brakes?

A. Not less than one-third nor more than two-thirds of the full stroke of the piston.

102. Q. What travel of piston should the tender brakes be adjusted for ?

A. Not less than five inches nor more than six inches, and such adjustment must be made whenever the piston travel is found to exceed eight inches.

SPECIAL FOR TRAINMEN.

103. Q. How should you proceed to test the air brakes before starting out, after a change in the make-up of a train, or before descending certain specially designated grades?

A. After the train has been fully charged with air, the engineman must be signaled to apply the brakes; when he has done so, the brakes must be examined upon each car to see that the air is applied and that the piston travel is not less than five inches nor more than eight inches, on a passenger car, or nine inches on a freight car. The engineman must be then signaled to release the brakes, and this signal must be given by the train air signal from the rear car, if it is in use upon the train; after he has done so, each brake must be examined again to see that all are released. The engineman and conductor must then be notified that the brakes are all right, if they are found so.

104. Q. In starting out a passenger train from an inspection point, how many cars must have the brakes in service?

A. Every car upon the train.

105. Q. When might you cut out a brake upon a passenger car?

A. Never; unless it gets out of order while on the run, in which case it must be reported to the inspector at the end of the run, or upon the first opportunity which may give sufficient time to repair it.

106. Q. If a hose bursts upon the run what must be done, if the train is in a safe place?

A. The hose must first be replaced by a good one, and the engineman then signaled to release the brakes. The train must not proceed until the brakes have been reconnected and tested upon the train to see that all are working properly.

107. Q. If the train is not in a safe place when the hose bursts, what must be done?

A. The train pipe cock immediately ahead of the burst hose must be closed and the engineer signaled to release the brakes. The brakes at the rear of the burst hose must then be released by bleeding the auxiliary reservoirs, and the train must then proceed to a safe place to replace the hose and connect up the brakes, after which the brakes must be tested.

108. Q. If the train breaks in two, what must be done?

A. The cock in the train pipe at the rear end of the first section must be closed, and the engineman signaled to release the brakes. The two parts of the train must then be coupled, the hose connected and the brakes again released by the engineman. When it is ascertained that the brakes are all released, the train may proceed.

109. Q. Explain how the pressure-retaining valves are thrown into action or thrown out of action, and when this must be done.

A. The pressure-retaining valve is thrown into action by turning the handle of the valve to a horizontal position, and it is thrown out of action again by placing this handle in a vertical position pointing downward. This handle should be placed in a horizontal position at the top of a heavy grade, and it should always be returned to a vertical position at the foot of the grade, as otherwise the brakes will drag on any cars which still have the handle of the pressure-retaining valve in the horizontal position;

110. Q. If the brake of any car is found to be defective on the run, how should you proceed to cut it out?

A. By closing the cock in the cross-over pipe of the quick-acting brake, or in the triple valve of the plain automatic brake, and then opening the release cock in the auxiliary reservoir upon that car, leaving it open, if a passenger car, or holding it open until all the air has escaped from it, if a freight car.

111. Q. When it is necessary to cut out a defective brake upon a car, why should it always be cut out at the triple valve and never by the train pipe cock at the end of the car, even if it is the last car of the train?

A. The train pipe should always be open from the engine to the rear end of the last car, so that if the train breaks in two the brakes will be automatically applied before the parts of the train have separated sufficiently to permit damage to be done by their coming together again, and so that the brakes may be applied with the conductor's valve upon any car.

112. Q. Should the train pipe burst under any car, what must be done?

A. The train must proceed to the nearest switching point, using the brakes upon the cars ahead of the one with the burst pipe, where the car with the burst pipe must be switched to the rear of the train; the hose must then be coupled up to the rear car and the cock at the rear end of the next to the last car opened and the cock at the forward end of the last car closed, so that if the train should part between the last two cars the brakes will be applied.

113. Q. What is the conductor's valve, and what is its use?

A. It is a valve at the end of the branch pipe leading from the train brake pipe upon each passenger car; it is to be opened from the car in any emergency when it is necessary to stop the train quickly, and only then. When used it should be held open until the train is stopped, and then it should be closed.

114. Q. What is the air signal for, and how is it operated?

A. It is to signal the engineman, in place of the old gong signal, and it is operated by pulling directly downward on the cord, *and releasing immediately, allowing one full second to elapse between pulls.*

115. Q. If the car discharge valve on the air signal system is out of order or leaking on any car, how can you cut it out?

A. By closing the cock in the branch pipe leading from the train signal pipe to the discharge valve; to do so the handle of this cock should be placed lengthwise with the pipe.

116. Q. How is the slack taken up so as to secure the proper adjustment of piston travel?

A. By means of the dead truck lever, and if that is not sufficient, one or more holes must be taken up in the underneath connection and the adjustment then made by the dead truck lever.

SPECIAL FOR INSPECTORS.

117. Q. Do you understand that no passenger train may be started out with any of the brakes cut out of service?

A. I do.

118. Q. Why is it important that no leaks should exist in the air brake service?

A. Because they would interfere with the proper working of the brakes and might cause serious damage.

119. Q. What must be done with the air brake or air signal couplings when not united to other couplings, *on cars equipped with dummy couplings?*

A. They must be secured in the dummy coupling, so that the face of the dummy coupling will cover the opening of the hose coupling so as to prevent dust and dirt from entering the hose.

120. Q. If air issues from the release port of the *quick-action* triple valve when the brakes are off, what is the cause?

A. It is probably due to dirt on the rubber-seated emergency valve.

121. Q. How often must the cylinder and triple valves be examined, cleaned and oiled?

A. As often as once every six months on passenger cars and once in twelve months on freight cars, and the cylinders must be oiled once every three months with a small quantity of mineral oil. The dates of the last cleaning and oiling must be marked with *white paint* on the cylinders.

122. Q. To what travel of piston must the brakes be adjusted?

A. Not less than five inches nor more than six inches, and this adjustment must be made whenever the piston travel is found to exceed eight inches on a passenger car or nine inches on a freight car.

123. Q. How is the slack taken up so as to secure this adjustment?

A. By means of the dead truck lever, and if that is not sufficient one or more holes must be taken up in the underneath connection and the adjustment then made by the dead truck lever.

124. Q. What are the different holes in the outer end of the cylinder levers for, and why must the connections be pinned to the proper hole for each car?

A. These holes are to enable the adjustment of the brake pressure to be made according to the weights of different cars. The connection must be made to the proper hole in each case, according to the weight of the car, so as to give proper braking power, otherwise the brake will be inefficient, or the wheels may be slid under the cars.

E. W. Grieves, Chairman,
E. D. Bronner,
S. Higgins,
H. C. McCarty,
Committee M. C. B. Ass'n.

G. W. Rhodes, Chairman,
B. Haskell,
A. W. Ball,
A. M. Waitt,
C. H. Cory,
Committee A. R. M. M. Ass'n.

The President: Gentlemen, you have before you the report of Committee No. 11. What is your pleasure with reference to it? It is simply a question now of what to do with the report.

MR. MACKENZIE: I would move that this committee be continued, we receiving the report with the understanding that they have reported progress, and that the committee be continued in connection with the Master Car Builders' Association committee for another year.

THE PRESIDENT: You understand the motion, that this report be received, and that the committee be continued, to work jointly with the committee of the Master Car Builders' Association, and to report next year.

The motion was carried.

THE PRESIDENT: Gentlemen, after the programme of this meeting was published, a paper was submitted to the Executive Committee by Mr. Brangs, a member of our Association, relating to the application of electricity to railroad work, more particularly as a motor and means of propulsion, and the Executive Committee received the paper favorably and referred it to the Committee on Subjects with the recommendation that it should give it its sanction; and it has done so, with the proviso that it should be read if the members think that time permits. The reading of the paper would occupy about ten minutes. Is it your pleasure to hear the paper by Mr. Brangs?

A vote was taken upon this question, and it was decided in the affirmative.

Mr. Brangs not being then present, Mr. Cloud then read the paper, which is as follows:

THE APPLICATION OF ELECTRICITY TO STEAM RAILROADS.

The recent developments in the application of electricity to the present existing steam railroads, is a question that is of great interest to the practical railroad men of the present day. The many advantages to be gained by the partial substitution of electricity for steam in conjunction with the steam locomotive must be apparent to all wide-awake railroad managers. The tremendous inroads that have been made in the receipts of local passenger traffic, on the majority of steam railroads of today, by the electric trolley roads, makes it manifest that something must be done to check these inroads.

The demands of the traveling public, living in suburban towns, have become very fastidious of late, and justly so, from the adequate facilities afforded by the electric lines.

They have paralleled our railroads, in many cases to such an extent, that it has put the railroad managers to severe perplexity as to the best method of meeting this great competitor. Many railroads running from large cities into the suburbs, who have large suburban traffic, are at a loss to know how they can accommodate the demands of the public for more frequent trains without very materially increasing their operating expenses. This, of course, is a very grave matter, as short and frequent trains, with locomotive traction, are expensive, in view of the fact that each train must be fully equipped with locomotive engineer and fireman, and a full crew, whether there be three cars or ten cars.

The running of short and frequent trains by locomotive traction would not be so extravagant if the Motive Power Department had at all times such sizes and weights of locomotives as were best suited for the purposes required. The tendency of late years has been toward heavier and more powerful locomotives, so that when called upon they can haul the heaviest and largest trains; but it is only during certain hours of the morning and evening when traffic is heavy that they are required to haul such heavy trains, consequently at other hours one can see these same powerful and heavy locomotives hauling trains of one-quarter or one-third their actual capacity.

A locomotive weighing, say 50 tons, will have about 40 tons on the drivers, possibly more. The tender will weigh about 25 tons, and the coal and water 10 tons more. Therefore, out of 85 tons of engine, tender, coal and water, only about 40 tons rests on the drivers, or about 50 per cent. At slow speed the capacity of the locomotive depends not on the amount of work the steam in the cylinders can do, but upon the adhesion of the wheels to the track, or, in other words, upon the weight on the drivers. Now, as only one-half the weight rests on the drivers, the other half is useless, and is just so much dead weight that has to be hauled over the road for nothing. It can thus be readily seen that an electric motor under average speed, with half the total weight of the steam locomotive, would do just as much useful work, with less wear and tear on the roadbed and track.

By the partial substitution of electrical traction for the exclusive locomotive traction, this could be vastly and economically improved. The heavy locomotives could be still used for drawing heavy through express and freight trains, while the short and local trains could be run by electricity.

Most of the railroads running into large cities, which have a large commutation or suburban traffic, have four tracks running for some distance from such cities. In that event I would advocate your equipping two tracks with electricity, and running two or three car trains at short intervals, thereby making it a rapid transit system.

Almost every one of the trunk lines running into New York City have a more or less number of leased lines and branches, which are used as feeders for the trunk lines. These lines, also, are particularly favorable as regards grades and locations for the trolley lines, which are great competitors, in many cases paralleling them for many miles, and, unfortunately for the railroad companies, carrying passengers in many cases for less than one-half the fares that were charged by the steam railroad companies. In one case particularly, Philadelphia, I believe, one of the large steam lines lost so much traffic that it has attempted to regain it by reducing prices and increasing the number of trains. In this it has partially succeeded, but at greater expense and decreased receipts. There are certain kinds of local traffic which the steam railroads must, to a large extent, lose, and which, in the nature of things, they cannot regain. In large cities having considerable suburban traffic, the trolley roads, forming, as they do, a network of lines in the city and extending in every direction into the suburbs, offer advantages with which the steam railroad cannot compete. As far as these branch lines go, whether it would pay to partially or wholly substitute electricity for steam depends upon the local conditions prevailing.

I would advocate, as far as possible, the equipping of these small branches electrically, and as the gauge of roadbed and other things would be the same, this would greatly facilitate the matter while change of construction was going on. I fully believe that if many of the small branches of the various railroads centered around New York City were equipped electrically, so that short and frequent trains could be run at a profit, it would add very materially to the advantages of the trunk line.

Objection will be made that the trolley, or the third rail, as the case might be, would interfere with the operation of the steam railroad, but I see no reason why they could not be run jointly. During such hours of the day when traffic might be light, freight might be drawn by electric motors to the various small towns along the line, which rarely have more than one or two cars. This in itself would be a very great saving, as now special freight trains have to be made up. The consumer is now often put to great inconvenience by only getting one freight train a day, whereas by the partial substitution of electricity, these cars could be drawn by the same electric motors or motor cars used for the passenger traffic. Another important adjunct to this would be the quick delivery of express matter, which is, of course, a source of great revenue to the railroad companies.

As to the nature of the equipment that will be required, it would depend upon the work to be done and the branch to be equipped. In some cases it might be well to use single electric cars, while in other cases two or three car trains could be used.

In a very able article written some years ago by Mr. O. T. Crosby, on " The Limitations of Steam and Electricity in Transportation," he made very thorough researches into the subject of the costs of repairs to steam locomotives versus the electric motor, and from deductions arrived at he reasoned that the cost of repairs to motors would not be more than thirty per cent of the amount expended on steam locomotives. At the same time this article was written, however, it is doubtful whether these claims could have been substantiated. It is a well-known fact that the construction and efficiency of electric motors have been vastly improved, and I venture to say that if he was correct then in allowing that the cost of repairs would not be more than thirty per cent that of steam locomotives, it can reasonably be supposed to be very much less today.

It is conceded by all well-informed engineers that the locomotive is an unbalanced machine, and cannot be made otherwise. The moving parts of a steam engine can be balanced either in a vertical or a horizontal direction, but not in both. A locomotive can be balanced vertically by placing a counterbalance weight in the driving wheel, opposite the crank, about equal to the crank pin and half the connecting rod; to balance it horizontally it is necessary to make this weight equal all the moving parts, that is to say, the piston, piston rod, cross-head, connecting rod and crank pin. If the latter weight is used the machine will be more out of balance vertically than if no weight at all was used, therefore the best result is obtained by taking a weight that overbalances vertically and underbalances horizontally. As the engine is out of balance vertically, the result is that the track is subjected to a series of shocks, being detrimental to the roadbed and bridges.

William Baxter, Jr., in an able article recently published in the *Electrical Engineer*, in comparing the efficiency of the tests obtained from the engine drawing the Empire State Express on the New York Central Railroad, states: "They have shown results as high as 3¼ pounds of coal per horse-power per hour, but the conditions under which such tests have to be made are such that it is very difficult, if not actually impossible, to obtain exact results. The power developed by locomotives, as shown by the indicator cards, can be considerably out of the way. This fact is recognized by steam railroad engineers, and few if any of them would undertake to claim that the results of these tests represent the average working efficiency of locomotives in high-speed service. It is very doubtful whether the average everyday work of high-speed passenger locomotives can show a result much below four pounds per horse-power hour. Assuming that the coal consumption of a locomotive will average in actual service about four pounds per horse-power hour for express engines, five pounds for local passenger, and six pounds for freight. There is another class of work for which locomotives are used, in which the coal consumption per horse-power of useful work performed is very great; just how much it is impossible to say, but in all probability it is in the neighborhood of twenty pounds per horse-power hour, and in some cases may go even higher. The work referred to is that of drill engines. Of course these engines cannot be taken into consideration in an estimate of the relative efficiency of locomotives and electric motors, because their wastefulness is due to the fact that while they are burning coal all the time, they are only developing horse-power for short periods at a time.

" The average efficiency of large stationary engines is conceded to be about two pounds of coal per horse-power hour. The data presented in the foregoing sustain the claim that the substitution of electricity for steam would effect a saving of about fifty-five per cent of the coal bill. The saving of coal alone, however, is not the all-important factor upon which hangs the future destiny of electricity in the steam railway field. In the first place, we have the very important fact that the electric motor does not depend upon the skill of the man who handles it for its efficiency, while the locomotive does. No matter what the intelligence of the motorman may be, the energy absorbed in doing a given amount of work with the same motor will always be the same. This is by no means the case with the locomotive. There are two ways by which the speed of a locomotive can be regulated. One by the movement of the link motion lever, the other by opening and closing the throttle. If the link motion lever is used, the steam will be expanded in the cylinders and the highest efficiency obtained. By using the link motion, the throw of the valve is shortened in precisely the same way as it is in the various types of high-speed engines that have a single valve, the motion of which is regulated by the governor. Under these conditions the locomotive becomes a variable cut-off engine, and works at a high rate of efficiency, but when the throttle is used to regulate the speed, it becomes simply a slide-valve engine, and uses a much greater amount of steam to do the same work.

" The amount of coal used to generate steam will further depend upon the skill and care of the fireman. This is one point in which steam is at a decided disadvantage when compared with electricity. It may be said that what is true of the locomotive is true of the engine at the power station of an electric system, but such is not the case. The engines regulate themselves by the action of the governor.

" And so far as the efficient use of steam is concerned, they are no more dependent upon the skill of the engineer than the motor is. As to the wastefulness of the engineer and fireman, it is not at all likely to be as great at a central station as on a locomotive."

Many of the large railroad companies introduced into their motive departments a system of rewards for the economical use of coal and engine supplies, but I understand that that system proved a failure from the fact that the engineers and firemen in their zeal to get the coveted rewards, frequently preyed upon one another, and often were so economical as not to use sufficient fuel as to enable them to make their running time. Now, in a central station, where everything is under the watchful eye of a capable and efficient engineer, and with the automatic mechanical stoking apparatus now at hand and adequate facilities for handling coal, and all other conveniences which go to make up a well equipped central station, unnecessary leakages cannot long exist.

The interest that manifested itself in the railroad world within the last few months in regard to electric traction is remarkable. The successful operation of the electric locomotive by the Baltimore & Ohio Railroad Company, with which you are familiar, and the more recent operation of the electric traction by the New York & New Haven Railroad Company at Nantasket Beach and the most recent installation of the third-rail system between Hartford and Berlin, Connecticut, is an evidence of the rapid advancement of this unseen power. The managers of the New York & New Haven Railroad Company are to be commended on the adoption of electricity for steam, from the fact that there have been numerous obstacles and difficulties to overcome. To design and construct motors for new conditions has always been a very expensive matter, and the New York & New Haven Railroad may be congratulated upon having installed at a remarkably short notice a successful and efficient electric railway system.

As regards the advisability of using either the third rail or the trolley: There has not been sufficient experience with the third rail on the New York & New Haven to fully demonstrate whether the change from the trolley to the third rail would be advisable. I certainly do not approve of the unprotected third rail, when it is open to all kinds of accidents and malicious interference. I understand there have been several accidents on the New York & New Haven from the exposed third rail.

Liability to accident could be easily avoided by the substitution of a rail at the side of the track, with a side contact, and then have the exposed parts covered over and insulated in such a way that any object falling from above, or persons stepping across, would not be so liable to come in contact with the exposed live rail.

There are many advantages, however, in the construction of a third rail over the trolley system, as it has been demonstrated by the conclusions arrived at by Colonel Heft, electrician of the New York & New Haven Railroad Company, that the cost of the third rail is about one-half that of the trolley system. It would therefore appear that it would commend itself to all practical railroad men as the best method of supplying the current.

The newspapers have reported a number of accidents to laborers from receiving shocks from the rail, but no serious effects have resulted, except from muscular contraction. As is well known to all electrical engineers, the voltage used for trolley roads is not necessarily fatal. I recall an experience. Some years ago, while testing a 600 volt current machine, the switch was closed by an attendant while I had both terminals in my hands, and I received the entire charge of 600 volts through my body for a period of about one minute. Notwithstanding the fact that it was extremely disagreeable, I did not experience any severe effects from it a half hour afterward.

In conclusion, I wish to say that the locomotive has still a long lease of life, but it must be apparent to all that electricity is about to supersede the steam locomotive in special cases.

MR. BRANGS : In justice to the paper just read, I want to say that it applies particularly to local conditions. I do not think that the locomotive has got to go for a great many years to come. I believe, however, that the application of electricity for the partial substitution of the steam railroad is a thing which we have got to face very soon. About New York, particularly, and Boston, Chicago and other large cities, there is a growing demand for more rapid transit. We well know that in the late meetings of the railroad clubs the discussion of rapid transit was one of the most interesting discussions that they had, and at the recent meeting of the New York Railroad Club, the universal opinion seemed to prevail that electric traction was about the most suitable method of applying power for rapid transit roads. As to the use of the third rail or the trolley, as I say in the paper, I think the trolley is by far the most effective. The third rail is open to considerable experiment, as yet, as recent results have shown on the New Haven Railroad. I think it is rather injudicious, in view of the fact that we have a live current right in the center of the track which is open to all malicious interference. The third rail, of course, has some advantages, but, on the whole, it must be changed considerably from what it is now. The method of applying it as it is applied on the elevated roads in Chicago, seems to be the best; that is to say, using an outside contact with the rail, or the contact rail considerably raised from the track, say, six or eight or ten inches, and then applying the shoe or contact brush from the side. Then I would suggest that the contact rail also be covered over with a hood or some kind of protection against interference. In regard to the dangers of the use of electricity, I do not think that the ordinary currents used are very dangerous. As I said in my paper, the electro-motive force usually used is about 500 to 550 volts, and that is not necessarily fatal. I have never known of a case where a man was shocked to death by such a current. The currents, of course, that are used at Niagara and other places where alternating currents are used, are somewhat more dangerous.

As I said before, I do not think the locomotive is going to go for a great many years; but I do think in special cases where we have a large suburban traffic and where locomotives cannot be found their representative, Mr. W. S. Morris, for his untiring efforts to make all in attendance happy and comfortable;

To the Pullman and Wagner Palace Car Companies; to the Norfolk & Western Railroad Company; to the Richmond Locomotive Works; to the Norfolk, Virginia Beach & Southern Railroad Company; to the Norfolk & Ocean View Railway Company; to the Old Dominion Steamship Company; and to the Merchants & Miners' Steamship Company, for substantial and highly appreciated transportation facilities;

To the proprietors of the Chamberlin and Hygeia hotels, for the courtesies and comfort of the numerous guests;

To the managers of the Hampton Normal and Agricultural Institute, for the opportunity of visiting their very interesting institute of education;

To the *Railway Age*, for the publication of reports of our proceedings, as well as other items of interest found in their valuable daily issue.

To the many committees of the Supply Men's Association, for the entertainments provided for the ladies, as well as ourselves;

Last, but not least, to the president and staff of our Association, for the able and progressive manner in which they have conducted its affairs.

William Garstang.
H. D. Gordon.
A. W. Gibbs.

The President: Gentlemen, what will you do with the report?

Mr. Sinclair: I move that it be received.

The motion was carried.

The President: The Constitution provides that the President shall announce at each meeting a committee to report at the next succeeding annual convention on the subjects to be assigned to committees for the second following annual convention. In that connection, I designate as the Committee on Subjects, to report at the convention of 1898, Messrs. C. H. Quereau, W. H. Thomas and Philip Wallis.

Is there anything further under the head of Routine and Miscellaneous Business to be considered? If not, we will suppose that you wish to resume the topical discussions which, under the By-Laws, come up at 12 o'clock. All other business being disposed of, if no objection is offered, we will now continue the topical discussions. Topical question No. 10: "Research Laboratory Under Control of American Railway Master Mechanics' Association," to be opened by Professor Goss.

Mr. Henderson: Would it be out of place to proceed to the election of officers and take up the topical discussion at 12 o'clock?

The President: Just as the members prefer.

THE PRESIDENT: The Secretary states in that connection that this report was formulated and handed in before the convention had so acted. But the convention did decide that there should be but eight subjects. I call your attention to the fact that in addition to those nine subjects proposed by the committee, two others have been authorized by the convention, one being the subject of Bolts and Nuts, the dimensions of the head, to be treated jointly with a committee of the Master Car Builders' Association, and the other, a continuation of the Committee on the Apprentice Boy; also the continuation of the Committee on Revision of the Air Brake and Signal Instructions. Those three, added to the nine submitted, make a total of twelve. It is suggested that you might place this list of twelve subjects in the hands of the Executive Committee, and empower them to strike out four of them, at their discretion.

MR. MACKENZIE: I move to that effect, Mr. President.

The motion was carried.

THE PRESIDENT: The next stage of our business is what is called in the programme "Routine and Miscellaneous Business." Under that head we will entertain the report of the Committee on Correspondence and Resolutions now in the hands of the Secretary.

Mr. Cloud read the following report:

REPORT OF THE COMMITTEE ON RESOLUTIONS.

FORTRESS MONROE, VA., June 15, 1897.

To the President and Members of the
American Railway Master Mechanics' Association:

Your committee recommends the adoption of the following resolution:

In recognition of the courtesy and hospitality of those who have contributed to the success and pleasure of the thirtieth annual convention of the American Railway Master Mechanics' Association,

Resolved, That the fullest appreciation and most hearty thanks of the Association be tendered to Col. Royal T. Frank and other officers of the United States military forces at Fortress Monroe, for their many acts of kindness and attention;

To the commander and officers of the United States Battleship Texas, for the pleasure and opportunity afforded our members to visit and thoroughly inspect that most wonderful piece of mechanical art, the Battleship Texas; and to Mr. William R. Trigg, the president of the Richmond Locomotive Works, for his successful efforts to secure the presence of that ship, and for the many other courtesies extended by him and the representatives of his company, to the convention;

To the Chesapeake & Ohio Railroad Company, its president, Mr. M. E. Ingalls, and general manager, Mr. G. W. Stevens, for their numerous courtesies, and to their representative, Mr. W. S. Morris, for his untiring efforts to make all in attendance happy and comfortable;

To the Pullman and Wagner Palace Car Companies; to the Norfolk & Western Railroad Company; to the Richmond Locomotive Works; to the Norfolk, Virginia Beach & Southern Railroad Company; to the Norfolk & Ocean View Railway Company; to the Old Dominion Steamship Company; and to the Merchants & Miners' Steamship Company, for substantial and highly appreciated transportation facilities;

To the proprietors of the Chamberlin and Hygeia hotels, for the courtesies and comfort of the numerous guests;

To the managers of the Hampton Normal and Agricultural Institute, for the opportunity of visiting their very interesting institute of education;

To the *Railway Age*, for the publication of reports of our proceedings, as well as other items of interest found in their valuable daily issue.

To the many committees of the Supply Men's Association, for the entertainments provided for the ladies, as well as ourselves;

Last, but not least, to the president and staff of our Association, for the able and progressive manner in which they have conducted its affairs.

WILLIAM GARSTANG.
H. D. GORDON.
A. W. GIBBS.

THE PRESIDENT: Gentlemen, what will you do with the report?

MR. SINCLAIR: I move that it be received.

The motion was carried.

THE PRESIDENT: The Constitution provides that the President shall announce at each meeting a committee to report at the next succeeding annual convention on the subjects to be assigned to committees for the second following annual convention. In that connection, I designate as the Committee on Subjects, to report at the convention of 1898, Messrs. C. H. Quereau, W. H. Thomas and Philip Wallis.

Is there anything further under the head of Routine and Miscellaneous Business to be considered? If not, we will suppose that you wish to resume the topical discussions which, under the By-Laws, come up at 12 o'clock. All other business being disposed of, if no objection is offered, we will now continue the topical discussions. Topical question No. 10: "Research Laboratory Under Control of American Railway Master Mechanics' Association," to be opened by Professor Goss.

MR. HENDERSON: Would it be out of place to proceed to the election of officers and take up the topical discussion at 12 o'clock?

THE PRESIDENT: Just as the members prefer.

MR. MCCONNELL: I move that we proceed to the election of officers.

The motion was carried.

THE PRESIDENT: The Constitution provides that the officers shall be elected without any nominations being made and also separately. That is, there can be no ticket. They must be elected by ballot. The President is to appoint two tellers to take the votes. I appoint as tellers, Mr. Sinclair and Mr. Pomeroy. Will the tellers please assist the Secretary in the distribution of the ballot blanks? Please record your vote by ballot for the office of President of the Association.

The vote for President was as follows: Total number of votes cast, 57; for Pulaski Leeds, 51; for Robert Quayle, 3; for W. S. Morris, 2; for A. E. Mitchell, 1.

THE PRESIDENT: Mr. Leeds is elected as the next President of the Association.

MR. HENDERSON: I move that we make it unanimous.

The motion was carried.

MR. LEEDS: Gentlemen, I thank you for the compliment, which is certainly appreciated, and I will try to deserve your confidence. [Applause.]

THE PRESIDENT: Gentlemen, prepare your ballots for First Vice-President.

The vote for First Vice-President was as follows: Total number of votes cast, 53; for Robert Quayle, 48; for J. H. McConnell, 3; for A. E. Mitchell, 1; for W. S. Morris, 1.

MR. MCCONNELL: Mr. President, I move that the election of Mr. Quayle be made unanimous.

The motion was carried.

MR. QUAYLE: Mr. President and Gentlemen,—I thank you for the undeserved compliment, and I assure you that the Association will get my untiring efforts, and I will endeavor, so far as my ability will allow me, to follow in the direction that our Chairman *leads*.

THE PRESIDENT: Please remember, that under the amendment to the Constitution adopted at our first session, you will have to elect not only a Second Vice-President, but a Third Vice-President as well. The ballot now to be taken is for Second Vice-President.

The vote for Second Vice-President was as follows: Total number of votes cast, 63; for J. H. McConnell, 36; for W. S. Morris, 16; for A. E. Mitchell, 5; for William Forsyth, 1; for G. W. West, 3; for O. Stewart, 2.

THE PRESIDENT: A majority of the total number of votes cast elects, and Mr. McConnell is declared elected Second Vice-President.

MR. MORRIS: I move that the vote be made unanimous.

The motion was carried.

MR. MCCONNELL: Mr. President and Gentlemen,—In railroad service we use a big wheel for speed and a small wheel for a pull. I wish to say that I will pull with the balance of the members of the convention. [Laughter.]

THE PRESIDENT: Please understand that you are now to prepare and cast your ballots for Third Vice-President.

The vote for Third Vice-president was as follows: Total number of votes cast, 64; for W. S. Morris, 57; for A. E. Mitchell, 5; for Edward M. Herr, 1; for J. N. Barr, 1.

MR. MITCHELL: I move that the election of Mr. Morris be made unanimous.

The motion was carried.

MR. MORRIS: Mr. President and Gentlemen,—I indeed appreciate in the highest degree the honor you have so kindly bestowed upon me. I cannot but feel that in doing so the Association has demonstrated fully its indorsement of our efforts to make you welcome, and as my Company has granted almost unlimited scope to make our meeting a success, I cannot be so selfish as to claim personally this elegant support. I therefore wish to call your attention particularly to our President, Mr. M. E. Ingalls, who, unfortunately for us, was absent at the opening, and also to our General Manager, Mr. G. W. Stevens, who, by their magnanimous and broad-gauge spirit, have given your Committee of Arrangements the means by which their every effort seemed apparently satisfactory. I thank you personally and will endeavor to do my duty as one of your officers to the best of my ability. [Applause.]

THE PRESIDENT: Gentlemen, before proceeding to ballot for Treasurer, I would like to say that I am authorized by your present Treasurer, Mr. Stewart, to say that his decision, as set before you at the first session, is final, and that he would not be able to accept a re-election to the office of Treasurer, even if you should honor him in that way. You will, therefore, please prepare your ballots for Treasurer.

MR. MITCHELL: While the tellers are collecting the ballots, I move that it is the sense of this meeting that a vote of thanks be extended to the retiring Treasurer for the able manner in which he has handled the funds of this Association. (Seconded.)

The motion was unanimously carried.

PROFESSOR GOSS: Is a motion in order?

THE PRESIDENT: It will be entertained.

PROFESSOR GOSS: Inasmuch as the topical discussions were arranged especially for the noon hour, and inasmuch as we are to have no noon hour today, I move that the list of topical discussions which has not yet been taken up may be continued to next year.

THE PRESIDENT: Do I understand your motion to be that the balance of the topical questions which have not been taken up shall be carried over till next year?

PROFESSOR GOSS: Carried over till next year.

MR. HENDERSON: I would like to amend that by suggesting that next year we begin at No. 11. I think we would all be interested in hearing No. 10 discussed before we adjourn today. (Seconded.)

THE PRESIDENT: Does Professor Goss accept that amendment?

PROFESSOR GOSS: I think my motion would be better.

THE PRESIDENT: Then you must vote on the amendment as offered by Mr. Henderson.

MR. QUEREAU: In that case I would like to offer another amendment to the effect that the Executive Committee be requested to include Topical Question 10, which is "Research Laboratory under Control of American Railway Master Mechanics' Association," as a committee subject for next year. It may be suggested that we have subjects enough already, but it has been agreed that the Executive Committee should have discretion to throw out or keep in any they please. I would say, for the Committee on Subjects, that we thought this was important enough for a committee investigation, and we thought we would put it in the topical questions to see how much interest would be taken in it in the convention. Possibly Mr. Henderson will accept that amendment.

Mr. Henderson : I will accept that if it does not do away with the ten-minute discussion of the subject today. We want that, anyhow, to stir up the interest a little for you.

The President : Gentlemen, the question is on Mr. Henderson's amendment, that the modification suggested by Mr. Quereau and agreed to by Mr. Henderson, that we should proceed after the elections have been closed to have a ten-minute discussion of Subject No. 10, "Research Laboratory," and that that subject should be included in the list of subjects from which the eight subjects for 1898 are to be chosen ; further, that the balance of the subjects listed for topical discussion should go over for 1898.

The motion was carried.

The President : The tellers will now announce the result of the ballot for Treasurer.

The vote for Treasurer was as follows : Total number of votes cast, 56 ; for J. N. Barr, 32 ; for Angus Sinclair, 21 ; for William Garstang, 3.

Mr. McConnell : I would move that the election of Mr. Barr as Treasurer be made unanimous.

The motion was carried.

The President : Under the ruling you have just made, we will now proceed to a ten-minute discussion of Topical Question No. 10, "Research Laboratory Under Control of American Master Mechanics' Association," to be introduced by Professor Goss.

Mr. Humphrey : Don't we ballot for the next meeting place ?

The President : That is not subject to a process of balloting, as I understand it, but may be discussed. That can be done after the topical discussion.

Professor Goss : Mr. President and Gentlemen,— The first question that arises is, if we had a laboratory, what would be its work and how would we do it ? and it is to this question only that I will address myself. I will offer no arguments in favor of such laboratory. I assume that the facts which the mechanical department of a railroad requires may be grouped into two classes : First, those which are necessary for the conduct of routine work, such as tests of the strength of materials and of oils, lubricants, and so forth ; and second, facts which are to guide future practice — that is, research facts. A laboratory, if one were to exist, would carry on the routine work in much the same way that existing laboratories of large roads carry on that work. We will assume that there is a central laboratory, that it is supported by some means to which all roads contribute. Roads having this routine work done would be expected to pay the cost to the laboratory, and the small roads which now are unable to secure, at any ordinary cost, results of this sort, would thus be able to command the facilities of a large establishment. It is not expected that the larger roads would abandon their present laboratories. They would have no interest in this central laboratory so far as the routine work is concerned, except that by giving the smaller roads an opportunity to accomplish what they — the larger roads—already have, they would greatly multiply the amount of valuable data in a short time so that other perplexing questions could be taken up through the study of such data. The larger roads would not be taxed in any way to pay for this routine work, the purpose being, as I have said, to have each road pay for what it gets. So much for the routine work, which is the minor work of such a central laboratory, as I conceive it.

In matters of research, we should have contributions from all roads interested available for carrying on the study, experimental or otherwise, of the larger problems which concern the interests of the roads in general. This work in detail could be carried out through committees of this Association as at present, committees being chosen to investigate certain subjects. Instead, however, of taking the time of the chairmen of these committees, or taking the equipment of the roads upon which these chairmen happen to serve, thus making the contribution to the Association the contribution of a few individuals or a few roads, these committees could at once apply to the central laboratory sustained by all roads, and through the force organized in this central laboratory and the facilities which have been brought into existence in this central laboratory, every required research could be made and reports of results made from the laboratory to the committee, reviewed by the committee and finally brought before this Association. Thus it would place in the hands of this Association an expert force and a laboratory equipment which would be paid for by all roads receiving benefit, and not as at present by the few roads upon which experiments may chance to be made. Now this, in brief, is a possible scheme for a laboratory, as it has occurred to me since I was asked to open the discussion of the subject. As I said, I will not force upon you any arguments in its favor.

Mr. Gaines : I believe there is one radical objection to the centralization of a laboratory which has just occurred to me. Suppose we have a lot of iron to test. I doubt if we could have a sample of that sent to the laboratory, tested and reported in less than a week's time. During that time you might want the iron very badly, and during that time you are holding the car out of service.

Mr. Quereau : In answer to the gentleman, I would say that it was my fortune once to assume control of a laboratory, both the chemical and physical departments of it, at a time when the railroad papers advertised the fact that the chemists had both resigned. Within the first three months after this occurred, the impression got abroad that material subject to chemical analysis could not be analyzed. More material was condemned than in any two years preceding that time or any two years succeeding those three months. I believe that a central laboratory would be worth all that it would cost in securing to the buyers of material, material of good quality.

I would like to call the attention of the convention also to the fact — possibly my judgment is wrong in this respect, but it seems to me that the most important reports that we have had of late years have been those which have been conducted after laboratory methods. You will all commend the report of the Committee on Steam Passages and Exhaust Pipes. It is probable that the data gathered there and the rules and laws laid down will stand for years. The results of the tests of the Committee on Brake Shoes are very valuable and were made by laboratory methods. It seems to me that the railroads themselves are appreciating these facts, in view of the growing number of railroad laboratories which are being sustained by individual railroads. But, as was suggested by Professor Goss, it is almost impossible — or hardly fair, I had better say — for one railroad to undertake such a series of tests as was involved in either of these reports, while if each company contributed its small quota to the general expense, all would be benefited and the results would be very valuable and lasting, I have no doubt, and would save the cost over and over again.

Mr. Herr : Mr. President, this matter is undoubtedly one of a very great deal of importance, and, as such, is hardly one with which we can deal in the proper way without some preparation. I therefore move you that a committee be appointed to report at the next annual meeting. Do I understand that that has been done ?

THE PRESIDENT: That has been disposed of. The time has practically expired. Is there any further discussion?

I am requested to make this announcement, that traction-power computers are to be found on the desk of the Hotel Chamberlin for members who have not received them.

Any further business? Is it desired that there shall be any mention or discussion of the place of the next meeting?

MR. LEEDS: I think we took a vote on that the other day and settled it finally. There is only one place in the United States that will accommodate the two conventions at the same time. It could not be done here, and I do not know of any place where it can be done conveniently anywhere in these United States except in Saratoga.

MR. SPRAGUE: I think if we are going to settle down to Saratoga, we might as well assume that and follow it. It seems to me that we ought not to meet there all the time unless we must. I should be very much in favor of meeting at Niagara Falls. I think it is a more desirable place, and in view of the fact that we have met in Saratoga two or three times in five or six years, I think we ought to go elsewhere. I have no doubt they can take care of us at Niagara Falls. I understand they can, and in view of the great improvements made there, the Gorge road, and the electric plant, I would be in favor of Niagara Falls.

MR. LEEDS: I would say that I do not know of any place that would be preferable to Niagara Falls. The natural scenery anyone should enjoy. Buffalo is only a few miles away with the finest drives in the world. At the same time, I do not know of any hotels at Niagara Falls that can, in addition to their transient business, accommodate 2,500 people, which would be what it practically means if the two conventions sit there at the same time. There are several considerations to be made in choosing a place for a meeting. In the first place, we have got to go where we can control the attendance. If we go where there are a great number of transient guests we certainly lose control of our conventions. At the same time, I do not think that there are accommodations at Niagara Falls, or even in Niagara Falls and Buffalo combined, to take care of 2,500 people in addition to their transient business.

MR. HUMPHREY: It was suggested that we go where Pulaski *leads* a short time ago; but in view, I might say, of the ignorance developed on his part in regard to the hotel accommodations in certain sections, I do not think that I am ready to follow him just at the present time. The rotunda of the Brown Palace Hotel in Denver is larger than all the hotels that the gentlemen has just mentioned [laughter], and I am sure that if the gentleman will take a trip through the western country he would be in a much better condition—more able to *lead* this convention than he is at the present time. I believe that if the convention—and especially the Master Car Builders' convention that has just adjourned—would come out there and experience some of the exhilarating influences of the air in that section of the country, it would do them a great deal of good. I mention Denver, as it is suggested that Manitou might divide them. Manitou Springs would accommodate either convention nicely without any trouble, and in case there is any doubt existing in regard to Manitou, you need not have any fear as to Denver, as the Brown Palace Hotel will accommodate more people than these two hotels together.

MR. McCONNELL: Mr. Chairman, if I may be allowed to make a suggestion, I would suggest that the Executive Committee give consideration to the remarks of Mr. Humphrey.

MR. LEEDS: I believe it is understood that that will be done.

MR. McCONNELL: I hope so.

MR. LEEDS: And as I understand it, it is not a matter of following where Pulaski *leads* in this matter, but his understanding of what the Association has laid down as the line that he has got to follow in connection with the Executive Committee, and as far as I am informed I do not know of a place out there where the convention could be accommodated, and while I have a great inclination to go a good ways west, at the same time I cannot help thinking that the Windy City is about the limit.

MR. McCONNELL: I would suggest that we accept Mr. Leeds' apology.

MR. LEEDS: I hope that will be seconded and carried.

THE PRESIDENT: Is there any further business?

MR. BRIGGS: I move that we adjourn. (Seconded.)

THE PRESIDENT: Before yielding up the gavel, I wish to thank you, one and all, for the uniform courtesy and support which I have enjoyed at your hands.

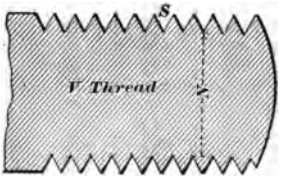
The convention then adjourned.

STANDARDS ADOPTED BY THE AMERICAN RAILWAY MASTER MECHANICS' ASSOCIATION.

SCREW THREADS.

At the Third Annual Convention the report of a Committee recommending the United States standard screw thread was adopted. Annexed are the forms and dimensions of the threads in question.

Fig. 1.



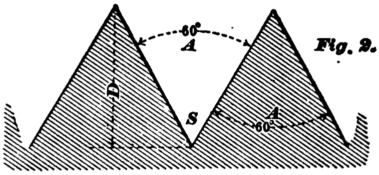
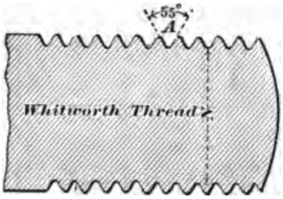


Fig. 2.

Fig. 3.



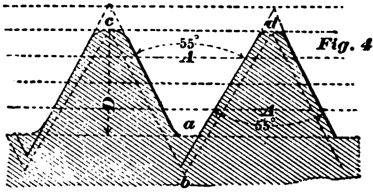
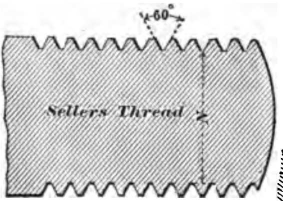


Fig. 4.

Fig. 5.



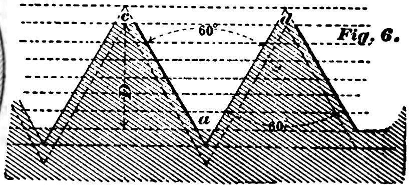
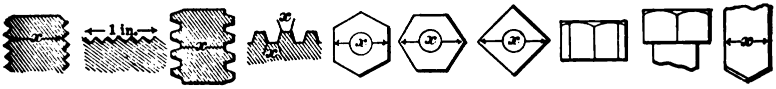


Fig. 6.

SCREW THREADS. SELLERS' STANDARD.

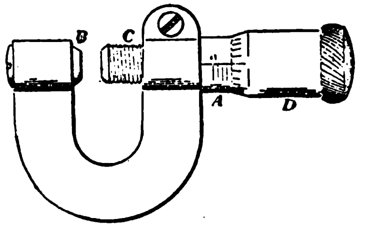
The Association at the Twenty-fifth Annual Convention adopted the United States standard sizes of nuts and bolt heads, particulars of which are given below:



Diameter of Screw.	Threads per Inch.	Diameter at Root of Thread.	Width of Flat.	Short Diameter of Hexagon or Square.	Long Diameter Hexagon.	Long Diameter Square.	Thickness Nuts.	Thickness Heads.	Tap Drill.
1/4	20	.185	.0062	1/2	37/64	7/10	1/4	1/4	3/16
5/16	18	.240	.0074	19/32	11/16	10/12	5/16	19/64	1/4
3/8	16	.294	.0078	11/16	51/64	63/64	3/8	11/32	5/16
7/16	14	.344	.0089	25/32	9/10	1 7/64	7/16	25/64	23/64
1/2	13	.400	.0096	7/8	1	1 15/64	1/2	7/16	13/32
9/16	12	.454	.0104	31/32	1 1/8	1 23/64	9/16	31/64	15/32
5/8	11	.507	.0113	1 1/16	1 7/32	1 1/2	5/8	17/32	17/32
3/4	10	.620	.0125	1 1/4	1 7/16	1 49/64	3/4	5/8	5/8
7/8	9	.731	.0138	1 7/16	1 21/32	2 1/32	7/8	23/32	3/4
1	8	.837	.0156	1 5/8	1 7/8	2 19/64	1	13/16	27/32
1 1/8	7	.940	.0178	1 13/16	2 3/32	2 9/16	1 1/8	29/32	31/32
1 1/4	7	1.065	.0178	2	2 5/16	2 53/64	1 1/4	1	1 3/32
1 3/8	6	1.160	.0208	2 3/16	2 17/32	3 3/32	1 3/8	1 3/32	1 3/16
1 1/2	6	1.284	.0208	2 3/8	2 3/4	3 23/64	1 1/2	1 3/16	1 9/32
1 5/8	5 1/2	1.389	.0227	2 9/16	2 31/32	3 5/8	1 5/8	1 9/32	1 13/32
1 3/4	5	1.491	.0250	2 3/4	3 3/16	3 57/64	1 3/4	1 3/8	1 1/2
1 7/8	5	1.616	.0250	2 15/16	3 13/32	4 5/32	1 7/8	1 15/32	1 5/8
2	4 1/2	1.712	.0277	3 1/8	3 5/8	4 27/64	2	1 9/16	1 3/4
2 1/4	4 1/2	1.962	.0277	3 1/2	4 1/16	4 61/64	2 1/4	1 3/4	1 31/32
2 1/2	4	2.176	.0312	3 7/8	4 1/2	5 31/64	2 1/2	1 15/16	2 3/16
2 3/4	4	2.426	.0312	4 1/4	4 29/32	6	2 3/4	2 1/8	2 7/16
3	3 1/2	2.629	.0357	4 5/8	5 3/8	6 17/32	3	2 5/16	2 5/8
3 1/4	3 1/2	2.879	.0357	5	5 13/16	7 1/16	3 1/4	2 1/2	2 29/32
3 1/2	3 1/4	3.100	.0384	5 3/8	6 7/64	7 39/64	3 1/2	2 11/16	3 1/32
3 3/4	3	3.317	.0413	5 3/4	6 21/32	8 1/8	3 3/4	2 7/8	3 11/32
4	3	3.567	.0413	6 1/8	7 3/32	8 41/64	4	3 1/16	3 19/32
4 1/4	2 7/8	3.798	.0435	6 1/2	7 9/16	9 3/16	4 1/4	3 1/4	3 13/16
4 1/2	2 3/4	4.028	.0454	6 7/8	7 31/32	9 3/4	4 1/2	3 7/16	4 1/32
4 3/4	2 5/8	4.256	.0476	7 1/4	8 13/32	10 1/4	4 3/4	3 5/8	4 9/32
5	2 1/2	4.480	.0500	7 5/8	8 27/32	10 49/64	5	3 13/16	4 1/2
5 1/4	2 1/2	4.730	.0500	8	9 9/32	11 23/64	5 1/4	4	4 3/4
5 1/2	2 3/8	4.953	.0526	8 3/8	9 23/32	11 7/8	5 1/2	4 3/16	4 31/32
5 3/4	2 3/8	5.203	.0526	8 3/4	10 5/32	12 3/8	5 3/4	4 3/8	5 7/32
6	2 1/4	5.423	.0555	9 1/8	10 19/32	12 15/16	6	4 9/16	5 7/16

SHEET METAL GAUGE.

At the Fifteenth Annual Convention the Brown & Sharp micrometer gauge shown below was adopted as standard for the measurement of sheet metal.



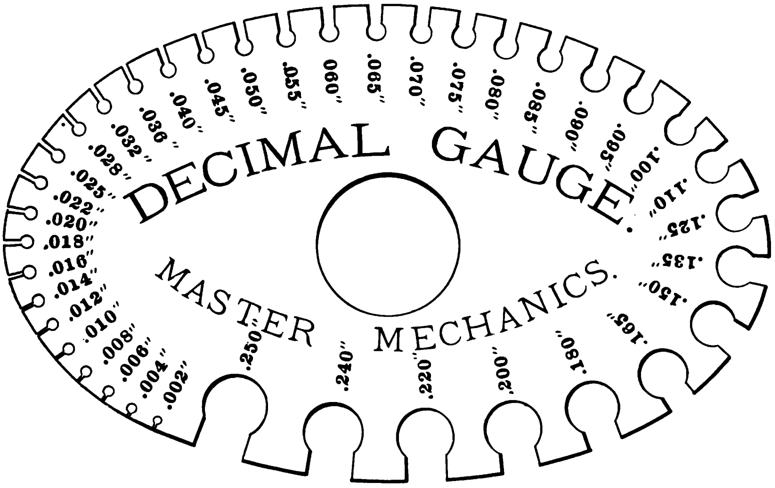
DECIMAL GAUGE.

At the Twenty-eighth Annual Convention the following was adopted as standard decimal gauge:

1st. The micrometer caliper should be used for laboratory and toolroom work, and in the shop when specially desired.

2d. The solid notch gauge should be used for general shop purposes.

3d. The form of this gauge shall be an ellipse whose major axis is 4 inches, the minor axis 2.5 inches, and the thickness .1 inch, with a central hole .75 inch in diameter.



4th. The notches in this gauge shall be as follows:

.002″
.004″
.006″
.008″
.010″
.012″
.014″
.016″
.018″
.020″
.022″
.025″
.028″
.032″
.036″
.040″
.045″
.050″
.055″
.....
.060″
.065″
.070″
.075″
.080″
.085″
.090″
.095″
.100″
.....
.110″
.125″
.135″
.150″
.165″
.180″
.200″
.220″
.240″
.250″

5th. All notches to be marked as in the above list.

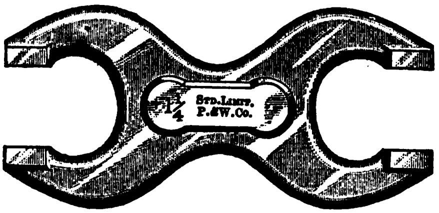
6th. The gauge must be plainly stamped with the words "Decimal Gauge" in capital letters .2 inch high, and below this the words "Master Mechanics."

7th. In ordering material, the term gauge shall *not* be used, but the thickness ordered by writing the decimal as in above list. For sizes over ¼ inch, the ordinary common fractions may be used.

LIMIT GAUGES.

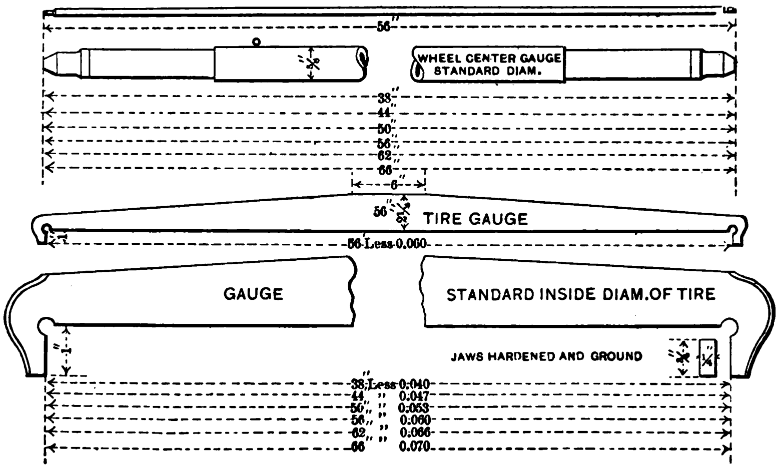
At the Seventeenth Annual Convention the Pratt & Whitney limit gauges for round iron, illustrated on this and following page, were adopted. The sizes are as follows:

Nominal Diameter. Of Iron. Inches.	Large Size, End. Inches.	Small Size, End. Inches.	Total Variation. Inches.
¼	.2550	.2450	.010
5/16	.3180	.3070	.011
⅜	.3810	.3690	.012
7/16	.4440	.4310	.013
½	.5070	.4930	.014
9/16	.5700	.5550	.015
⅝	.6330	.6170	.016
¾	.7585	.7415	.017
⅞	.8840	.8660	.018
1	1.0095	.9905	.019
1⅛	1.1350	1.1150	.020
1¼	1.2605	1.2395	.021



DRIVING-WHEEL CENTERS AND SIZES OF TIRES.

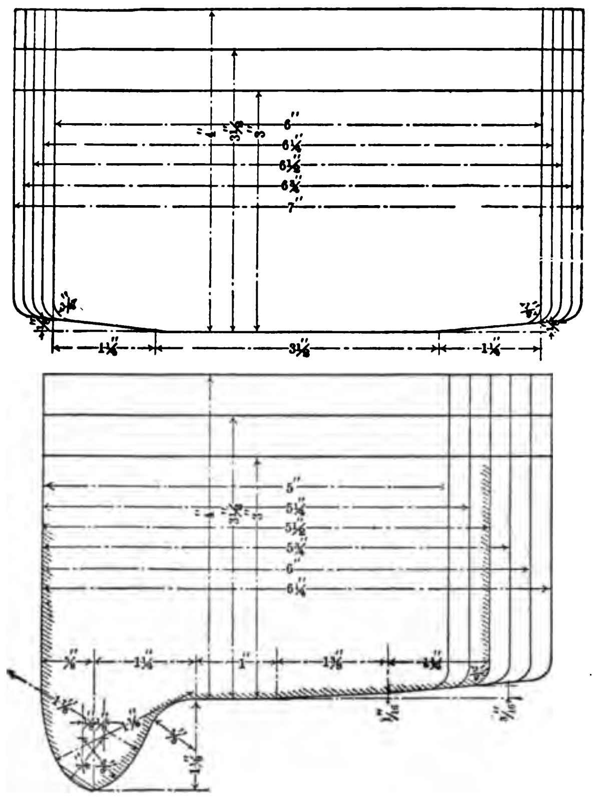
At the Nineteenth Annual Convention the report of a committee was adopted which recommended driving-wheel centers to be made 38, 44, 50, 56, 62 or 66 inches diameter. At the Twentieth Annual Convention the recommendations of a committee were adopted, making tire gauges manufactured by Messrs. Pratt & Whitney, Hartford, Connecticut, and here illustrated, standards of the Association. The sizes and the allowance for shrinkage are as follows.



At the Twenty-sixth Annual Convention the following sizes were adopted as standard for large driving-wheels: 70, 74, 78, 82, 86 and 90 inches.

STANDARD FORMS OF TIRES.

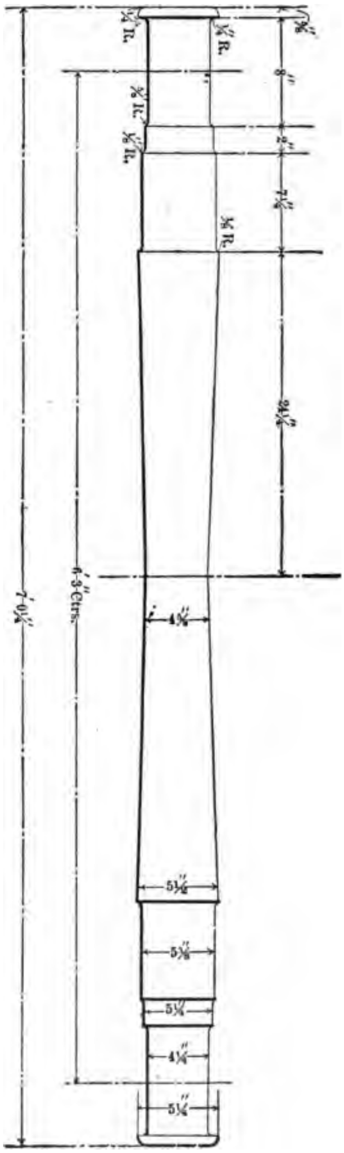
At the Twenty-sixth Annual Convention the forms of tires shown in the annexed engraving were adopted as standard. Railroad companies ordering tires will save time by specifying these forms.



At the Twenty-ninth Annual Convention a minimum thickness of 1 inch for the flanges of engine and truck wheels was adopted as standard practice; determination to be made by M. C. B. flange thickness gauge. See Proceedings for 1896.

AXLE FOR HEAVY TENDERS.

The accompanying illustration shows the dimensions of the axles for heavy tenders recommended by a committee of the Association.



METHOD QF CONDUCTING LOCOMOTIVE TESTS.

Adopted at the Twenty-seventh Annual Convention; full details, page 166, Twenty-seventh Annual Report.

BOILER STEEL SPECIFICATIONS.

Adopted at Twenty-seventh Annual Convention; full details, page 68, Twenty-seventh Annual Report.

SPECIFICATIONS AND TESTS FOR LOCOMOTIVE IRON BOILER TUBES, EXTRA QUALITY.

Adopted at Twenty-eighth Annual Convention.

Material.

Tubes to be made of knobbled hammered charcoal iron and lap-welded.

Dimensions and Weights.

Tubes 2 inches, outside diameter.

.095	inch	thick and	weight	at least	1.91	lbs.	per foot.
.110	"	"	"	"	2.19	"	"
.125	"	"	"	"	2.97	"	"
.135	"	"	"	"	2.65	"	"

Tubes 2¼ inches, outside diameter.

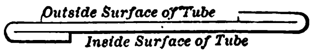
.095	inch	thick and	weight	at least	2.16	lbs.	per foot.
.110	"	"	"	"	2.48	"	"
.125	"	"	"	"	2.80	"	"
.135	"	"	"	"	3.01	"	"

Surface Inspection.

Tubes must have a smooth surface, free from all laminations, cracks, blisters, pits and imperfect welds. They must also be free from bends, kinks and buckles—signs of unequal contraction in cooling or injury in manipulation—and must be of uniform thickness throughout, except at weld, where .015 inch additional will be allowed, perfectly round and cut to exact length ordered.

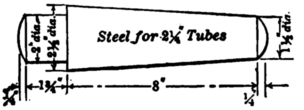
Physical Tests.

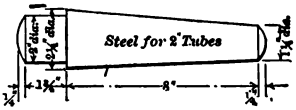
1. Strips one-half inch in width by six inches in length, planed lengthwise from tubes, after being heated to a cherry red and dipped in water at 80 degrees Fahrenheit, shall bend in opposite directions at each end as shown in sketch below, without showing cracks or flaws; and when nicked and broken these must show a fracture wholly fibrous, or a test in a testing machine may be substituted for this.



2. Sections of tubes 12 inches long—five inches of which shall be heated to a *bright cherry red* in daylight—when placed in a vertical position, and a smooth-turned tapered steel pin at a *blue heat* is driven in, by "lap" blows with a 10-pound sledge hammer, must stretch to one and one-eighth times their original diameter without split or crack. One tube to be tested, as required in paragraphs 1 and 2, in each lot of 250 tubes or less.

The sketches below show dimensions of steel pins to be used for 2-inch and 2¼-inch O. D. tubes.





3. Tubes must expand, turn over tube plate and bend down without flaw, crack or opening at weld.

Hydraulic Test.

Each tube must be subjected, by the manufacturer, to an internal pressure of 500 pounds to the square inch.

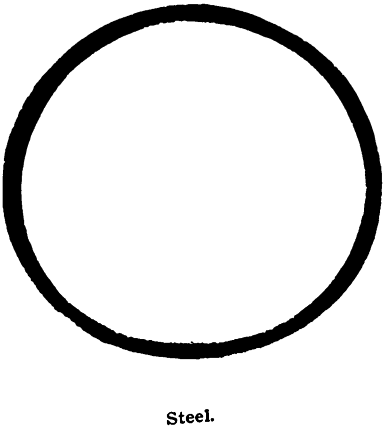
Etching Tests.

In case of doubt as to the quality of material, the following tests shall be used, namely:

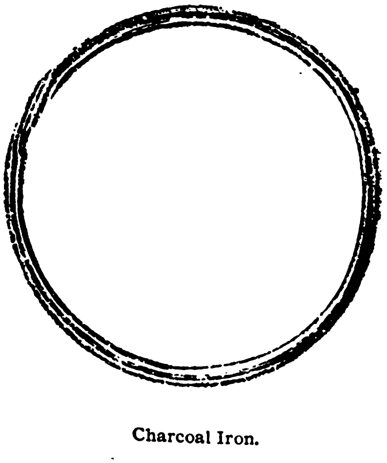
A section of tube turned or ground to a perfectly true surface, polished with fine emery paper, and free from dirt and grease, to be suspended in a bath of

Water........................	9 parts.
Sulphuric acid................	3 "
Muriatic "	1 "

The bath should be prepared by placing the water in a porcelain dish, adding the sulphuric acid and then the muriatic acid. Chemical action is allowed to con-



Steel.



Charcoal Iron.

tinue until the soft parts are sufficiently dissolved so that an iron tube will show a more or less finely ridged surface, with the weld very distinct; a steel tube will present a homogeneous surface.

General Requirements.

Each tube must be plainly stenciled "Knobbled Hammered Charcoal Iron" and "Tested to 500 Pounds," and tubes must be so invoiced. Each tube must also be subjected to careful surface inspection, as provided for above; and those measuring one sixty-fourth of an inch over or under the diameter ordered shall be rejected.

Obituary.

DAVID LEONARD BARNES.

David L. Barnes was born at Smithfield, near Providence, Rhode Island, August 23, 1858, and died in New York City, December 15, 1896. When he was only fifteen years of age his father died, and young Barnes became the head of the family, and at once began to display that self-reliance and responsible judgment which afterward characterized the man. In 1876 he entered Brown University, receiving after leaving there the degree of Master of Arts. He afterward entered the Massachusetts Institute of Technology as special student, and carried on engineering work during his vacations. From 1879 to 1887 he served in various capacities in the Rhode Island, the Hinckley and the Rome Locomotive Works. During the latter part of this period he became chief draftsman and mechanical engineer at the Rhode Island Works. In 1887 he began practice as consulting engineer, establishing his headquarters at Chicago, and conducting his engineering practice until the time of his death.

For a number of years before his death he was one of the editors of the *Railroad Gazette*, and very largely influenced the conduct of that paper in mechanical matters, especially in locomotive engineering.

Mr. Barnes' activity during the last eight years of his life was a constant source of wonder to his friends. He was a prolific writer, not only for the paper with which he was connected, but for the various technical societies and railway clubs, as well as for our own Association. The only book which bears his name is the revised edition of "Compound Locomotives," first issued by Professor Woods; this book being, to date, the most comprehensive collection of descriptive data we have upon the subject.

As consulting engineer, Mr. Barnes was responsible for the design of many details in car and locomotive practice in various important works undertaken for his clients. He was engineer for the "Alley" Elevated Railway in Chicago, and had general supervision of the design of its equipment. His last important work was in connection with designing a set of standard electric locomotives for the combined interests of the Baldwin Locomotive Works and the Westinghouse Electric and Manufacturing Company. This absorbed the greater part of his energies during the last two years of his life, and perhaps was the most congenial work he had undertaken, calling into play, as it did, his strong analytical powers, combined with experience as a steam railroad machinery designer.

Mr. Barnes' contributions to the Association, both in the shape of committee work and discussions at our annual meetings, were constant, and he was looked upon as one of our most valued speakers. In committee work especially, many of our members will remember with gratitude the interest he took in the preparation of reports and his readiness to relieve his fellow-members of tedious detail work.

GEORGE GIBBS.
WILLIAM FORSYTH.
W. F. M. GOSS.

THOMAS INGLIS.

Thomas Inglis, Master Mechanic of the St. Louis Southwestern Railway Company, of Texas, died at his home in Tyler, Texas, July 29, 1896.

Mr. Inglis was born June 8, 1849, near Glasgow, Scotland: He served an apprenticeship of seven years at the machinist and engineering trade, was then appointed second engineer on a steamship sailing between Liverpool and the west coast of Africa, and continued in this service for six years. Coming to the United States, he engaged with the Vulcan Iron Works at Carondelet, Missouri, and remained with that company for five years; was then appointed Master Mechanic of the Carbondale Coal and Coke Company Railway, which position he occupied for three and one-half years; was then employed as general foreman of the St. Louis, Iron Mountain & Southern Railway at DeSoto, Missouri, for three and one-half years. He then entered the employ of the St. Louis Southwestern Railway Company as general foreman at Tyler, Texas, and held this position for two years. In 1891 he was promoted to the position of Master Mechanic, which position he held until the time of his death. Mrs. Inglis and one daughter survive him.

Mr. Inglis held the full confidence of the men under his control, was kind-hearted and charitable, with a pleasant word for all, and was a prominent member of the Cumberland Presbyterian Church. He will be greatly missed in the community in which he lived, beloved by all who knew him.

R. M. Galbraith.
F. Hufsmith.
J. W. Addis.

WILLARD G. TABER.

Willard G. Taber was born in New Hampshire in 1838, and died February 17, 1897, suddenly, of heart failure. He was buried in Manchester, New Hampshire, with Knights Templar honors.

Mr. Taber, at the age of sixteen, entered the shops as an apprentice in Manchester, New Hampshire. After two years in the shops he took a position of locomotive fireman on the Central Vermont Railroad, and one year later, at the age of nineteen, was promoted to the position of locomotive engineer. A few years later he moved to Pittsburg, Pennsylvania, accepting employment as locomotive engineer on the P. Ft. W. & C. R. R., where he remained as passenger engineer for many years, running fast trains between Pittsburg and Alliance. In 1876 he was selected to make the then fast run of the Jarret Palmer train over his division, which made a famous record at that time between New York and San Francisco. In 1876 he accepted the position of roundhouse foreman with the Fitchburg R. R. and removed to Boston, Massachusetts. Four years later he was appointed roundhouse foreman of the Eastern Division of New York & New England road, where he remained, filling this and other positions for nearly eight years. In 1889, on account of change of management, Mr. Taber, with many other officials, left the service of this road, and in 1890 he secured the position of Master Mechanic with the Dunkirk, Allegheny Valley & Pittsburgh R. R., with headquarters at Dunkirk, New York, which position he filled till his death.

Mr. Taber was twice married, his first wife having died in Pittsburg. One son and one daughter by first marriage are living, the former at present time being a trusted locomotive engineer on the Fitchburg R. R. His second wife and four young children also survive, and have removed from Dunkirk to Manchester, New Hampshire, where they now reside. Several brothers and sisters also survive. As a railroad man Mr. Taber was loyal, energetic, and trusted by his superior officers, and kind and sympathetic to his subordinates, a brother to his friends, exemplary as husband and father, generous always, with malice or ill-will toward none. He was a member of the Pittsburg Lodge of Freemasons, and the Dunkirk Chapter, Council and Commandery.

He was buried, mourned for all by all who knew him, and with befitting full Templar honors.

A. E. Mitchell.
H. Tandy.

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